PACIFIC CONSOLIDATED INDUSTRIES

INSTRUCTION MANUAL
HOSPITAL OXYGEN BACKUP SYSTEM
PART NUMBER 790570-001

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PACIFIC CONSOLIDATED INDUSTRIES

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1.0 SAFETY PRECAUTIONS

1.1 General

High pressure gas containers and their contents are very dangerous. The sudden release of this gas can cause the container to respond like a missile, careening across the ground and through the air. Extreme care must be taken when handling charged cylinders and filling them.

1.2 Moving Cylinders

Cylinders shall not be dragged or slid. Where practical, a suitable hand truck, forktruck, roll platform or similar device where the container can be secured for transporting should be used. Cylinders should not be dropped or permitted to strike against each other or other surfaces violently.

Caps should not be used for lifting cylinders. Do not expose cylinders to excessive temperatures (greater than 130 Deg F (54 Deg C)).

1.3 Relief Valves

Never shut off a line without having a suitably rated relief valve or a bleed-off valve between the two shut-off valves.

1.4 Heat of Compression

Filling cylinders too rapidly by not having enough cylinders on the charging manifold can cause heat build up in the gas. A temperature too high could cause problems with seals in the valves, ignition in oxygen systems, etc. Always check the surface temperature of the cylinders periodically during charging operations. Magnetic mount temperature indicators are provided to measure the cylinder wall temperature.

1.5 Mixing Gases

Never use cylinders marked for gases other than the gas to be charged into the cylinder. Always check the marking of the cylinder to insure only cylinders marked for oxygen are charged with oxygen and only cylinders marked for nitrogen are charged with nitrogen.

2.0 CHARGING INSTRUCTIONS

2.1 Installing Cylinders on Manifold

2.1.1 Contamination. Use extreme care not to let contamination enter the lines, valves, manifold, or cylinders. Do not use any greases or oil on the threads. Any valves installed by the user for oxygen service must have oxygen compatible materials, and be cleaned for oxygen service.

2.1.2 Installation. Install cylinders at each manifold station. Connect pigtails from manifold to each cylinder. Connect manifold to Recharger gas discharge fitting. See drawing number 790574 for recommended installation scheme.

2.2 Evacuating cylinders

If any of the cylinders to be charged is completely empty, or are suspected to have other than oxygen gas, they should be evacuated using the vacuum pump of the recharger.

2.2.1 Vent to atmosphere all cylinders to be evacuated by opening V1, V2, V6, and the individual V3 valves of the cylinders to be evauctated. After 0 psi is reached, close V6.

2.2.2 Connect the vacuum line from the recharger to the vacuum input on the HOBS. Open V4 and V5. If "D" cylinders are to be evacuated, open V7, V8 and the individual valves on each cylinder. Note: All 5 leads on each star manifold must be connected to a "D" cylinder.

2.2.3 Start the recharger vacuum pump. Operate until the pressure indication is at least 27 inches.

2.2.4 Close V4, V5 and cylinder valves. Turn off pump.

2.3 Charging

To insure that sufficient oxygen is available for transfilling "D" cylinders, the cylinders should be charged when the pressure falls below 1400 psi.

1) Connect recharger discharge hose to recharger quick connect fitting on manifold.

2) Open V6 and allow recharger to discharge during cool down to purge manifold for 1 minute minimum.

3) Close V6.

4) Open V1 and V2, and all Valves to the cylinders, V3A through V3H.

5) Make sure V4, V5, V7 and V8 are closed.

6) Start and prime the pump as described in recharger manual. The discharge pressure gauge should show a rise in pressure. While the pressure is increasing:

a) Check for leaks around manifold and pigtail connections.

b) Check for heat of compression in each cylinder by placing bare hand or temperature indicator on cylinder wall just below shoulder curve. A cylinder too hot to the touch or over 120 Deg F is considered to be charging too rapidly. A cylinder colder than the others should be checked to be certain that the valve is in the full open position. If it is, the suspect cylinder should be removed from the line. The contents should be emptied through the safety valve assembly and the valve replaced or repaired.

c) At about 1500 psig (103 bar), check each cylinder valve for leaks by soaping around the valve packing nut, safety nut and butt threads. Brush and container to be kept oxygen clean. Use only Ivory Liquid diluted in water.

NOTE

Do not use a squirt can or squirt gun to apply the soap solution. Wipe cylinder valve clean after every test.

d) Charge cylinder to 2250 psig at 70 Deg F. Increase filling pressure 5 psi for every degree above 70 Deg F. Decrease filling pressure 5 psi for every degree below 70 Deg F. Use nomagram and temperature indicator for determining proper pressure.

NEVER TRY TO STOP A LEAK UNDER PRESSURE. When there is a possibility that a cylinder valve is obstructed or isn't working properly follow the procedure outlined below:

1) Remove the cylinder from the building.

2) Loosen the safety nut or plug slightly and allow any gas contained within the cylinder to escape slowly.

CAUTION

While loosening the nut or plug always stand to one side in case the nut or plug should blow out.

3) After all the gas has been emptied from the cylinder, completely remove the safety device.

4) Remove the valve and repair or replace it.

Leaks

a) Packing nut or outlet thread leak: Close cylinder valve, close manifold valve, and after all pressure is off, tighten to stop leak (but do not over torque). If leak continues, remove cylinder for repairs.

CAUTION

NEVER TRY TO STOP A LEAK UNDER PRESSURE.

Once cylinders are fully charged:

a) Close V3A through V3H.

b) Shut down liquid pump.

c) Soap test packing nut, safety device and butt thread for leaks. Wipe clean after test.

d) Vent header pressure by opening V6 or pump priming valve.

e) After pump discharge lines have warmed up, close V6 and/or pump priming valve.

2.4 Shutting Down

2.4.1 Shut liquid pump and vaporizer fan down.

2.4.2 Close liquid pump suction valve at tank.

2.4.2 After pump has warmed up somewhat, close the vent valve.

2.4.4 Shut off electric power switch on door of Recharger control box.

3.0 TRANSFILLING "D" CYLINDERS

Never transfill less than 10 "D" cylinders at a time.

3.1 Procedure

3.1.1 Set cylinders in the pockets at the end of the HOBS mounting frame.

3.1.2 Check yokes and cylinder valves for cleanliness. Clean any surfaces that have residue, oil, grease, etc., with a lint-free rag and an approved oxygen compatible cleanser, i.e. Trichloroethane (see CGA Pamphlet G4.1).

3.1.3 Attach yokes to valve fittings on the "D" cylinders. Tighten securely to insure a leak tight seal.

3.1.4 Fully open the valves on all ten cylinders, V3A thru V3H.

3.1.5 Attach a magnetic mount thermometer on one cylinder of each 5 cylinder manifold.

3.1.6 Slowly open one isolation valve (V7 or V8) and adjust so the filling rate is approximately 200 psi per minute. Open the other isolation valve and adjust it for the same filling rate. This can be monitored on PI-5 and PI-6 mounted on each 5 station manifold.

3.1.7 Periodically touch the cylinders to see, if they are getting too warm. They should not be too hot to touch. Monitor the thermometers during the filling time. The temperature should not exceed 120 Deg F. If the cylinders are too hot, reduce the filling rate by adjusting V7 and/or V8.

3.1.8 If any cylinder feels colder than another, it means it is not filling at the same rate as the others or it is not filling at all. Check the valve on the cylinder to see if it is closed or possibly obstructed. If the cylinder cannot be made to come to the same temperature as the others, it should be removed and taken to a secure location for inspection of the valve.

3.1.9 Once the pressure in the "D" cylinders balances with the pressure in the backup cylinder manifold, the filling operation is complete

3.1.10 Close the isolation valves V7 and V8. Close the valves on all of the "D" cylinders. Slowly release one yoke fitting from each bank of 5 cylinders to allow the pressure to bleed from the lines.

3.1.11 Once the pressure on PI-5 and PI-6 reaches 0 psi, remove the yokes from all of the cylinders. Carefully stow the pigtails in the pockets.

3.2 Pressure Change

The backup cylinder pressure will be reduced by about 8% for every "D" cylinder transfilling operation. If the backup manifold pressure is below 1500 psi prior to transfilling 10 "D" cylinders, the manifold should be recharged.

TRANSFILLING OF HIGH PRESSURE GASEOUS OXYGEN TO BE USED FOR RESPIRATION

COMPRESSED GAS

PLEASE NOTE:

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This document should not be confused with federal, state, provincial, or municipal specifications or regulations, insurance requirements or national safety codes. While the Association recommends reference to or use of this document by government agencies and others, this document is purely voluntary and not binding.

SECOND EDITION 1987

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1. INTRODUCTION

It is imperative that users of this document take note of the following statement:

CAUTION

This publication is provided as a service by the Compressed Gas Association for persons and organizations who transfill gaseous oxygen to be used for respiration. It is *not* a procedures guide for transfilling; rather, it points out the safety concerns, regulatory compliance requirements, and potential hazards of transfilling. ***This document is not to be considered as an approval of this potentially hazardous activity.*** Cylinders should be filled only by trained and qualified personnel using components and equipment as set forth in this document. Transfilling should be performed only in facilities where effective controls and safety procedures have been established and are well understood and enforced. ***It is emphasized that transfilling attempted by unskilled, untrained persons (such as might be encountered in a private home environment) constitutes an extremely hazardous operation and is not condoned.***

Oxygen to be used for medical purposes is a drug. Its packaging requires specifically prescribed tests and recordkeeping and must be done in a facility registered annually with the Food and Drug Administration (FDA). In the United States, the regulations of the Department of Transportation (DOT), and the Occupational Safety and Health Administration (OSHA) apply. In Canada, requirements of the Canadian Transport Commission (CTC); Transport Canada (TC); Canadian Standards Association (CSA); Health and Welfare Canada, Health Protection Branch; *Transportation of Dangerous Goods Regulations*, and other government agencies and publications also apply. The National Fire Protection Association's publication, NFPA 99, *Standard for Health Care Facilities*, contains restrictions for transfilling in medical facilities. [1][1] and [2].

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[1]NOTE: References in this document are shown by bracketed numbers and are listed in the order of appearance. See Section 6, References.

1.1 Purpose. This publication describes the primary hazards involved in the transfilling of high pressure gaseous oxygen and advises that, before engaging in this practice, it is essential to be familiar with the hazardous properties of oxygen, required safety precautions, and the applicable government regulations.

1.1.1 This publication also describes minimum requirements for equipment which is used in transfilling.

1.2 Scope. This publication applies to small, high pressure cylinders, fitted with Connection CGA 540 or CGA 870, being transfilled from cylinders having pressures not exceeding 3000 psig at 120°F (20 684 kPa at 48.9°C), with a water volume not exceeding 514 cubic inches (8.43 liters), E size or smaller.

1.2.1 Cylinders for oxygen are also available different connections (CGA 577 for cylinders 001 to 4000 psig at 120°F (20 691 kPa to 27 578 a at 48.9°C), and CGA 701 for cylinders of 4001 to 500 psig at 120°F (27 585 kPa to 37 920 kPa at 48.9°C). Transfilling from these high pressure cylinders is considered extremely hazardous even by qualified personnel and should not be attempted. These pressures are at or near the rupture pressure of most small cylinders fitted with Connection CGA 540 or CGA 870.

1.2.2 Should transfilling from cylinders with pressures in the 3001 to 4000 psig (20 691 kPa to 27 578 kPa) or 4001 to 5500 psig (27 585 kPa to 37 920 kPa) ranges be attempted, with full knowledge of the associated potential hazards, the use of a suitable regulator and pressure relief devices must be assured.

1.3 Personnel Qualifications. Transfilling should only be performed by trained, qualified personnel who are familiar with the precautions necessary to avoid the hazards listed in Section 2. They must be familiar with the procedures necessary to comply with the government regulations outlined in Section 3.

1.4 Operating Instructions. Detailed written operating instructions to be followed shall be

provided by the manufacturer of the equipment to be used in the transfilling procedure and must include equipment inspection and maintenance procedures.

2. HAZARDS OF TRANSFILLING

Transfilling of gaseous oxygen from one cylinder to another involves hazards associated with the handling of gas under high pressure, the oxidizing property of oxygen which supports vigorous combustion, and the possibility that the repackaged oxygen may have become contaminated.

2.1 Description of Gaseous and Liquid Oxygen. Oxygen is an element which at ambient pressure and temperature exists as a colorless, odorless, tasteless gas. About one-fifth of the earth's atmosphere is oxygen (20.95% by volume). Oxygen is 1.1 times as heavy as air. Above its critical temperature of -181.4°F (-118.6°C), oxygen can exist only as a gas regardless of the pressure.

2.1.1 Liquid oxygen is light blue in color and flows like water. It boils at -297.3°F (-183.0°C) at standard atmospheric pressure and is 1.14 times as heavy as water. Gaseous oxygen at ambient pressure and temperature will occupy a volume approximately 860 times the volume occupied by the same amount of oxygen in its liquid form.

2.1.2 The outstanding properties of oxygen are its abilities to sustain life and to support combustion.

2.2 Some Hazards of High Pressure Gaseous Oxygen. Although oxygen itself is nonflammable, materials which burn in air will burn much more vigorously and at a higher temperature in oxygen-enriched atmospheres. If ignited, some combustibles such as oil burn in oxygen with explosive violence. Some other materials which do not burn in air will burn vigorously in oxygen-enriched atmospheres.

2.2.1 A hazardous condition does exist if high pressure oxygen equipment becomes contaminated with hydrocarbons such as oil, grease, or other combustible materials which may include oil from the operator's hands or contaminated tools. Ignition temperatures are reduced in oxygen-enriched atmospheres. There have been incidents where explosive rupture and burning of system components have resulted under these circumstances. Further details are provided in NFPA 410, *Standard on Aircraft Maintenance*. [3]

2.2.2 Oxygen under pressure presents a hazard in the form of stored energy. Accidents may result when this energy is not properly controlled. As stated in NFPA 410, "Physical damage to or failure of oxygen containers, valves, or piping can result in explosive rupture and fire in oxygen systems with danger to life, limb, and property." [3]

2.2.3 The rapid release of high pressure oxygen through orifices, needle valves, etc. in the presence of foreign particles can cause friction or impact resulting in temperatures which may be sufficient to ignite combustible materials and rapidly oxidize metals.

2.2.4 A cylinder will heat as it is filled from a high pressure source. The more rapidly the cylinder is filled, the higher the temperature rise in the cylinder resulting from the heat of compression of the gas. Excessive temperature may result in the ignition of any combustible materials that are present.

3. GOVERNMENT REGULATIONS

3.1 General. Persons or organizations engaged in the filling or transfilling of oxygen cylinders must understand and comply with the applicable regulations. The remainder of Section 3 is a partial list of the regulations which apply to the filling or transfilling of oxygen.

3.2 Department of Transportation: Title 49 of the Code of Federal Regulations. [4]

(1) 49 CFR 172.200: Describes requirements for shipping documents
(2) 49 CFR 172.400: Describes cylinder labeling requirements
(3) 49 CFR 173.1: Outlines training requirements for personnel preparing gas cylinders for shipment
(4) 49 CFR 173.34: Describes the requirements for qualification, maintenance, and use of compressed gas cylinders
(5) 49 CFR 173.301: Defines need for cylinder owner's consent prior to filling
(6) 49 CFR 173.302: Describes cylinder requirements and specifications

3.3 Food and Drug Administration: Title 21 of the Code of Federal Regulations. [5]

3.3.1 Federal Food, Drug, and Cosmetics Act, as currently amended.

(1) Section 201, Definitions
(2) Section 301 through 307, Prohibited Acts and Penalties
(3) Section 501, Adulteration
(4) Section 502, Misbranding
(5) Section 503, Exemptions
(6) Section 505, New Drugs

(7) Section 510, Registration of Producers
(8) Section 701 through 709, General Administrative Provisions

3.3.2 Title 21 of the *Code of Federal Regulations*

(1) 21 CFR Part 201, Labeling
(2) 21 CFR Part 207, Registration
(3) 21 CFR Part 210, Legal Status of Good Manufacturing Practices Regulations
(4) 21 CFR Part 211, Good Manufacturing Practices
(a) Subpart A: Describes general provisions, scope and definitions
(b) Subpart B: Describes personnel and organization requirements, responsibilities, and qualifications
(c) Subpart C: Describes buildings and facility requirements
(d) Subpart D: Describes equipment requirements
(e) Subpart E: Describes control of components and drug containers (including storage, testing and approval requirements)
(f) Subpart F: Describes requirements for prosing procedures and controls (including sampling .l testing requirements)
(g) Subpart G: Describes labeling and packaging requirements
(h) Subpart H: Outlines warehousing and distribution requirements
(i) Subpart I: Provides for laboratory controls
(j) Subpart J: Describes required records and reports

3.3.3 Compressed Medical Gases Guideline. Prepared by the FDA's Division of Drug Quality Compliance, the *Compressed Medical Gases Guideline* establishes acceptable interpretations of specific sections of the current Good Manufacturing Practice Regulations for drug products. [6]

3.4 Occupational Safety and Health Administration: Title 29 of the Code of Federal Regulations. [7]

3.4.1 29 CFR 1910.101 states: "Visual and other inspections [of compressed gas cylinders] shall be conducted as prescribed in the Hazardous Materials Regulations of the Department of Transportation."

3.5 Canadian Regulations. In Canada, the equivalent regulations are covered in the following ·lications: *Transportation of Dangerous Goods ·lations* [8]; *Regulations for the Transportation ·Dangerous Commodities by Rail* [9]; *Good Manu·cturing Practices for Drug Manufacturers and Importers* [10]; and *Identification of Medical Gas Containers, Pipelines and Valves* (CAN/CGSB-24.2-M86). [11]

3.6 State, Provincial, and Local Ordinances. State, provincial, and local ordinances also control the filling of compressed gas cylinders in many areas. In some states, additional State regulations and licensing may be applicable for the packaging of drugs.

4. TRANSFILLING SYSTEM AND EQUIPMENT

4.1 General. An oxygen transfilling system shall consist of the following: a supply cylinder unit, a receiving cylinder unit, a cylinder evacuation unit, a gas transfer control unit, and detailed written instructions provided by the equipment manufacturer. All systems shall be wall or frame mounted in a fixed location or permanently installed on a portable cart.

4.1.1 Supply Cylinder Unit

4.1.1.1 All cylinder connections shall conform with CGA V-1, *American National, Canadian, and Compressed Gas Association Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*. [12]

4.1.1.2 The unit shall have a calibrated pressure gauge to indicate the supply cylinder pressure.

4.1.2 Receiving Cylinder Unit

4.1.2.1 All cylinder connections shall conform with CGA V-1. [12]

4.1.2.2 The unit shall have a calibrated pressure gauge to indicate the pressure in the cylinder being filled.

4.1.3 Evacuation Unit

4.1.3.1 The unit shall be so equipped that back flow of gases or pump lubricant cannot enter the cylinder being evacuated.

4.1.3.2 Connections, valving, and gauges shall be provided so that the cylinders to be filled can be evacuated to a vacuum of at least 25 inches (635 mm) of water vacuum (approximately 16.89 kPa absolute) or better. Any suitable oxygen compatible means of evacuation may be used.

4.1.3.3 The evacuation unit shall be protected against accidental exposure to high pressure.

4.1.4 Gas Transfer Control Unit

4.1.4.1 The gas transfer control shall, as a minimum, consist of the following:

(a) A means to isolate the supply cylinder unit from the receiving cylinder unit and to control the rate of gas flow;

(b) A means to limit the maximum rate of gas flow into the receiving cylinders to a maximum pressure rise of 200 psi/min (1379 kPa/min);

(c) A means to control the maximum pressure in the receiving cylinders to a pressure not higher than the cylinder service pressure adjusted for temperature.

4.1.5 Detailed Written Instructions

4.1.5.1 The manufacturer of the transfilling system shall provide detailed written operating instructions for use of the transfilling system.

4.1.5.2 The manufacturer of the transfilling system shall provide detailed written inspection and maintenance instructions for the system.

4.2 Transfilling System Materials and Oxygen Compatibility

4.2.1 Oxygen transfilling system components, including but not limited to valves, valve seats, lubricants, fittings, gaskets, and interconnecting equipment, including hoses, shall be compatible with oxygen under the conditions of temperature and pressure to which the components may be exposed in the containment and use of oxygen. Easily ignitable materials shall be avoided. Parts of equipment or systems shall be approved, listed, or proved suitable for use in oxygen service by tests.*

*NOTE: Compatibility involves both combustibility and ease of ignition. Materials that burn in air will burn violently in pure oxygen at normal pressure and explosively in pressurized oxygen. Also, many materials that do not burn in air will do so in pure oxygen, particularly under pressure. Metals for containers and piping must be carefully selected, depending on service conditions.

For example, the various steel alloys are acceptable for many applications, but some service conditions may call for other materials (usually copper or its alloys) because of their greater resistance to ignition and lower rate of combustion.

Similarly, materials that can be ignited in air have lower ignition energies in oxygen. Many such materials may be ignited by friction at a valve seat or stem packing or by the heat of compression produced when oxygen at high pressure is rapidly introduced into a system that is at lower pressure.

4.2.2 All components of the transfilling system shall be cleaned for oxygen service. Refer to CGA G-4.1, *Cleaning Equipment for Oxygen Service*. [13]

4.2.3 All components of the transfilling system shall be suitable for the maximum pressure to which they may be subjected.

4.2.4 High pressure flexible hose, if used in transfilling systems, shall comply with the requirements above and be free from odor.

4.3 Cylinders

4.3.1 Compressed gases are commercially available in cylinders which, in the United States, are manufactured to Department of Transportation (DOT) specifications. In Canada, cylinders were previously manufactured to the specifications of the Canadian Transport Commission (CTC). Authority for these specifications now lies with Transport Canada (TC), which incorporates by reference specifications developed by the Canadian Standards Association.

4.3.2 Cylinders are filled, maintained, and shipped in accordance with appropriate regulations.

4.3.2.1 TC/DOT cylinders are marked to indicate the specification number and the "service pressure" for which the cylinders are manufactured. This marking is normally located on the shoulder of the cylinder, and consists of a combination of numbers and letters. For example, the designation TC/DOT-3AA-2015 indicates that the cylinder was fabricated and tested in accordance with Specification 3AA for a service pressure of 2015 psig (13 893 kPa).

4.3.2.2 Additional marks, normally located beneath the above markings, include an identifying mark of the original cylinder owner and a serial number. In addition, the date of original manufacture and a symbol identifying the inspector are located on the shoulder of the cylinder. For example, "9D65" indicates the cylinder was manufactured in September 1965, and inspected by Doe Company.

4.3.2.3 Most cylinders must be periodically retested to assure their qualification for continued service. The date of this "retest" is stamped into or permanently affixed to the cylinder. Dates of previous tests must not be obliterated. Refer to CGA C-1, *Methods for Hydrostatic Testing of Compressed Gas Cylinders*. [14]

4.3.3 The markings on cylinders must not be changed except as specifically provided for in the regulations. Markings and labels on cylinders must be kept in readable condition.

4.4 Cylinder Valves, Regulators, and Pressure Relief Devices

4.4.1 Oxygen cylinders with working pressures up to 3000 psig (20 684 kPa) are supplied with Compressed Gas Association Connection CGA 540 or the pin-indexed Connection CGA 870. Cylinders having higher working pressures from 3001 to 4000 psig (20 691 to 27 578 kPa) and 4001 to 5500 psig (27 585 to 37 920 kPa) are fitted with Connections CGA 577 and CGA 701, respectively. Only oxygen

regulators or other fittings having corresponding connections shall be attached to the valves. Refer to CGA V-1, *American National, Canadian, and Compressed Gas Association Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections.* [12] Valves shall be equipped with a pressure relief device in accordance with federal regulations and CGA S-1.1, *Pressure Relief Device Standards—Part 1—Cylinders for Compressed Gases.* [15] This device is subject to the internal cylinder pressure at all times. Under no circumstances should any attempt be made to loosen, tighten, or otherwise tamper with the pressure relief device. Pressure relief devices shall be handled only by personnel who are trained in their function and maintenance.

4.4.1.1 Where other methods of providing pressure relief for cylinder pressure in compliance with federal regulations are used, the transfiller shall not attempt to make adjustments or repairs.

4.4.2 Cylinder valves, regulators, pressure relief devices, fittings, and connections are designed to operate safely within a specific pressure range. Connection of these devices to a higher pressure, without provision for adequate pressure regulation, is hazardous and shall not be attempted. A serious safety hazard can result from potential over pressurization with the possibility of violent explosive failure of the equipment.

4.5 Source of Oxygen Supply

4.5.1 The source of oxygen supply shall consist of one or more cylinders containing oxygen gas under high pressure.

4.5.2 If the transfilled oxygen cylinders are to be used for medical purposes, the supply cylinders shall be clearly labeled: OXYGEN USP.

4.6 Cylinders to be Filled

4.6.1 Cylinders shall be carefully examined to determine if they are suitable for filling with oxygen and comply with 4.1.2.1.

4.6.1.1 Steel cylinders must pass a visual inspection as outlined in CGA C-6, *Standards for Visual Inspection of Steel Compressed Gas Cylinders.* [16]

4.6.1.2 Aluminum cylinders must pass a visual inspection as outlined in CGA C-6.1, *Standards for Visual Inspection of High Pressure Aluminum Compressed Gas Cylinders.* [17]

4.6.1.3 Fiber reinforced high pressure cylinders must pass a visual inspection as outlined in CGA C-6.2, *Guidelines for Visual Inspection and Requalification of Fiber Reinforced High Pressure Cylinders.* [18]

4.6.2 Cylinders shall be inspected and tested as required by the government regulations listed in Section 3. Each employer shall determine that compressed gas cylinders under his control are in safe condition to the extent that this can be determined by visual inspection and other inspections required by these regulations. Cylinders failing to meet any requirement shall not be filled.

4.6.3 Cylinders shall be vented to atmospheric pressure and evacuated before being filled.

4.6.4 Cylinders shall not be filled for respiratory use if not in respiratory oxygen service.

4.7 Oxygen Transfilling Operation

4.7.1. The transfilling of gaseous oxygen shall be performed in a well-ventilated location posted with NO SMOKING signs, and with no sources of ignition within 10 feet (3.05 m) of the transfilling operation.

4.7.2 Transfillers shall use only filling equipment which has been manufactured to comply with the requirements of Section 4.

4.7.3 Transfillers shall follow instructions provided by the equipment manufacturer.

4.7.4 The transfiller shall affix proper identification label(s), as required by federal regulations, to each cylinder.

4.7.4.1 A cylinder charged with a compressed gas must not be shipped unless it was charged by or with the consent of the owner of the cylinder. Unless the transfiller is authorized, in writing, as an agent of the company whose product identification, precautionary warning, and gas purity labels are affixed to the cylinder to be refilled, those labels shall be removed from the cylinder before it is refilled, and shall be replaced by those identifying the transfiller. The transfiller is responsible for the cylinder and its contents.

4.7.5 The written procedures of transfillers must include adequate and appropriate steps and instructions to assure proper content in each cylinder, purity of content, recordkeeping, color marking in accordance with CGA C-9, *Standard Color-Marking of Compressed Gas Cylinders Intended for Medical Use*, labeling, and valving to meet federal, state, provincial, and local regulations. [19] In Canada, color marking must conform to CAN/CGSB-24.2-M86, *Identification of Medical Gas Containers, Pipelines and Valves.* [11]

4.7.5.1 The instructions must include a check-

list similar to Appendix A of CGA P-1, *Safe Handling of Compressed Gases in Containers*. [20]

5. STORAGE AND MAINTENANCE OF THE EQUIPMENT

5.1 General. Several of the basic but very important rules to be observed by persons handling cylinders are:

5.1.1 Cylinders should not be subjected to extremes of heat and cold.

5.1.2 Cylinders should be protected from corrosive atmospheres.

5.1.3 Cylinders should be handled so as to avoid dropping or physical abuse to the cylinder or any attachments.

5.1.4 Cylinders and equipment for handling oxygen should be stored in a clean, ventilated area, free of grease, oil, or other contaminants.

5.1.5 Cylinders shall be stored in accordance with CGA P-1, *Safe Handling of Compressed Gases in Containers*, CGA P-2, *Characteristics and Safe Handling of Medical Gases*, and applicable government regulations. [20] and [21]

6. REFERENCES

[1] *Transportation of Dangerous Goods Regulations*, Supply and Services Canada, Canadian Publications Centre, Ottawa, Ontario K1A 0S9.

[2] NFPA 99, *Standard for Health Care Facilities*, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

[3] NFPA 410, *Standard on Aircraft Maintenance*, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

[4] *Code of Federal Regulations*, Title 49 CFR Parts 100-199 (Transportation). Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

[5] *Code of Federal Regulations*, Title 21 CFR Parts 200-299 (Food and Drugs). Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

[6] *Compressed Medical Gas Guideline*, Division of Drug Quality Compliance (HFN-320), Food and Drug Administration, 5600 Fishers Lane, Rockville, MD 20857.

[7] *Code of Federal Regulations*, Title 29 CFR Parts 1900-1910 (Labor). Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

[8] *Transportation of Dangerous Goods Regulations*, Supply and Services Canada, Canadian Publications Centre, Ottawa, Ontario K1A 0S9.

[9] *Regulations for the Transportation of Dangerous Commodities by Rail*, Supply and Services Canada, Canadian Publications Centre, Ottawa, Ontario K1A 0S9.

[10] *Good Manufacturing Practices for Drug Manufacturers and Importers*, Supply and Services Canada, Canadian Publications Centre, Ottawa, Ontario K1A 0S9.

[11] *Identification of Medical Gas Containers, Pipelines and Valves* (CAN/CGSB-24.2-M86), Supply and Services Canada, Canadian Publications Centre, Ottawa, Ontario K1A 0S9.

[12] CGA V-1, *American National, Canadian, and Compressed Gas Association Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*, Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

[13] CGA G-4.1, *Cleaning Equipment for Oxygen Service*, Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

[14] CGA C-1, *Methods for Hydrostatic Testing of Compressed Gas Cylinders*, Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

[15] CGA S-1.1, *Pressure Relief Device Standards—Part 1—Cylinders for Compressed Gases*, Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

[16] CGA C-6, *Standards for Visual Inspection of Steel Compressed Gas Cylinders*, Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

[17] CGA C-6.1, *Standards for Visual Inspection of High Pressure Aluminum Compressed Gas Cylinders*, Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

[18] CGA C-6.2, *Guidelines for Visual Inspection and Requalification of Fiber Reinforced High Pressure Cylinders*, Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

[19] CGA C-9, *Standard Color-Marking of Com-*

pressed Gas Cylinders Intended for Medical Usé, Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

[20] CGA P-1, *Safe Handling of Compressed Gases in Containers,* Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

[21] CGA P-2, *Characteristics and Safe Handling of Medical Gases,* Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

ADDITIONAL REFERENCES

CGA P-15, *Filling of Industrial and Medical Nonflammable Compressed Gas Cylinders,* Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

PUBLICATIONS OF THE COMPRESSED GAS ASSOCIATION

Pamphlet No.	Title
-1	Methods for Hydrostatic Testing of Compressed Gas Cylinders
C-2	Recommendations for the Disposition of Unserviceable Compressed Gas Cylinders with Known Contents
C-3	Standards for Welding on Thin Walled Steel Cylinders
C-4	American National Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained
C-5	Cylinder Service Life—Seamless, Steel, High Pressure Cylinders
C-6	Standards for Visual Inspection of Steel Compressed Gas Cylinders
C-6.1	Standards for Visual Inspection of High Pressure Aluminum Compressed Gas Cylinders
C-6.2	Guidelines for Visual Inspection and Requalification of Composite High Pressure Cylinders
C-7	Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers
C-8	Standard for Requalification of DOT-3HT Seamless Steel Cylinders
C-9	Standard Color-Marking of Compressed Gas Cylinders Intended for Medical Use
C-10	Recommended Procedures for Changes of Gas Service for Compressed Gas Cylinders
C-11	Recommended Practices for Inspection of Compressed Gas Cylinders at Time of Manufacture
C-12	Qualification Procedure for Acetylene Cylinder Design
C-13	Guidelines for Periodic Visual Inspection and Requalification of Acetylene Cylinders
C-14	Procedures for Fire Testing DOT Cylinder Safety Relief Device Systems
C-15	Procedures for Cylinder, Design Proof and Service Performance Tests
C-16	Registration Program for Cylinder Owner Symbols
	Standard Connections for Regulator Outlets, Torches and Fitted Hose for Welding and Cutting Equipment
-2	Hose Line Check Valve Standards for Welding and Cutting
E-3	Pipeline Regulator Inlet Connection Standards
E-4	Standard for Gas Regulators for Welding and Cutting
E-5	Torch Standard for Welding and Cutting
E-6	Standard for Hydraulic Type Pipeline Protective Devices
E-7	Standard for Flowmeters, Pressure Reducing Regulators, Regulator/Flowmeter and Regulator/Flowgauge Combinations for the Administration of Medical Gases
G-1	Acetylene
G-1.1	Commodity Specification for Acetylene
G-1.2	Recommendations for Chemical Acetylene Metering
G-1.3	Acetylene Transmission for Chemical Synthesis
G-1.5	Carbide Lime—Its Value and Its Uses
G-1.6	Recommended Practices for Mobile Acetylene Trailer Systems
G-2	Anhydrous Ammonia
G-2.1	American National Standard Safety Requirements for the Storage and Handling of Anhydrous Ammonia; ANSI K61.1
G-2.2	Guideline Method for Determining Minimum of 0.2% Water in Anhydrous Ammonia
G-3	Sulfur Dioxide
G-4	Oxygen
G-4.1	Cleaning Equipment for Oxygen Service
G-4.3	Commodity Specification for Oxygen
G-4.4	Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems
G-4.5	Commodity Specification for Oxygen Produced by Chemical Reaction
G-5	Hydrogen
-3	Commodity Specification for Hydrogen
	Carbon Dioxide
	Standard for Low Pressure Carbon Dioxide Systems at Consumer Sites
.2	Commodity Specification for Carbon Dioxide
G-6.3	Carbon Dioxide Cylinder Filling and Handling Procedures for Beverage Plants; NSDA TD01
G-7	Compressed Air for Human Respiration
G-7.1	Commodity Specification for Air; ANSI Z86.1
G-8.1	Standard for Nitrous Oxide Systems at Consumer Sites
G-8.2	Commodity Specification for Nitrous Oxide
G-9.1	Commodity Specification for Helium
G-10.1	Commodity Specification for Nitrogen
G-11.1	Commodity Specification for Argon
G-12	Hydrogen Sulfide
P-1	Safe Handling of Compressed Gases in Containers
P-2	Characteristics and Safe Handling of Medical Gases
P-2.1	Recommendations for Medical-Surgical Vacuum Systems in Health Care Facilities
P-2.5	Transfilling of High Pressure Gaseous Oxygen to be Used for Respiration
P-2.6	Transfilling of Liquid Oxygen to be Used for Respiration
P-5	Suggestions for the Care of High Pressure Air Cylinders for Underwater Breathing
P-6	Standard Density Data, Atmospheric Gases and Hydrogen
P-7	Standard for Requalification of Cargo Tank Hose Used in the Transfer of Compressed Gases
P-8	Safe Practices Guide for Air Separation Plants
P-9	The Inert Gases—Argon, Nitrogen and Helium
P-10	Standard for Vinyl Chloride Monomer Tank Car Manway Cover and Protective Housing Arrangement and Emergency Safety Kit
P-11	Metric Practice Guide for the Compressed Gas Industry
P-12	Safe Handling of Cryogenic Liquids
P-13	Safe Handling of Liquid Carbon Monoxide
P-14	Accident Prevention in Oxygen-Rich and Oxygen-Deficient Atmospheres
P-15	Filling of Industrial and Medical Nonflammable Compressed Gas Cylinders
S-1.1	Pressure Relief Device Standards—Part 1—Cylinders for Compressed Gases
S-1.2	Pressure Relief Device Standards—Part 2—Cargo and Portable Tanks for Compressed Gases
S-1.3	Pressure Relief Device Standards—Part 3—Compressed Gas Storage Containers
V-1	American National, Canadian, and Compressed Gas Association Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections; ANSI B57.1; CSA B96
V-5	Diameter-Index Safety System (Non Interchangeable Low Pressure Connections for Medical Gas Applications)
V-6	Standard Cryogenic Liquid Transfer Connections
V-6.1	Standard Carbon Dioxide Transfer Connections
V-7	Standard Method of Determining Cylinder Valve Outlet Connections for Industrial Gas Mixtures
CGA-341	Standard Insulated Tank Truck Specification
SB-1	Hazards of Refilling Compressed Refrigerant (Halogenated Hydrocarbon) Gas Cylinders
SB-2	Oxygen-Deficient Atmospheres
SB-3	Evidence of Ownership of Compressed Gas Cylinders
SB-4	Handling Acetylene Cylinders in Fire Situations
SB-5	Hazards of Reusing Disposable Refrigerant (Halogenated Hydrocarbon) Gas Cylinders
SB-6	Nitrous Oxide Security and Control
SB-7	Rupture of Oxygen Cylinders in the Diving Industry
SB-8	Use of Oxy-Fuel Gas Welding and Cutting Apparatus
SB-9	Recommended Practice for the Outfitting and Operation of Vehicles Used in the Transportation and Transfilling of Liquid Oxygen to be Used for Respiration
SB-10	Correct Labeling and Proper Fittings on Cylinders/Containers
SB-11	Use of Rubber Welding Hose
TB-2	Guidelines for Inspection and Repair of MC-330 and MC-331 Cargo Tanks
TB-3	Hose Line Flashback Arrestors
TB-4	Product Certification: Health Care Industry Application
HB-2	Handbook of Compressed Gases—2nd Edition

... Publications and Audiovisual catalog contact.

Compressed Gas Association, Inc.
1235 Jefferson Davis Highway, Arlington, VA 22202

4.0 HOSPITAL BACKUP OPERATION

4.1 The HOBS provides an interface between the low pressure oxygen from the ROSE units and the hospital lines. Two low pressure oxygen inputs are provided as the primary source for the hospital, although one only can be used if only one ROSE unit is available. If the pressure of the oxygen source drops below 75 psi, then the HOBS cylinders automatically feed the hospital lines through Regulator R-3. If 2 ROSES are connected, the secondary ROSE will automatically start supplying oxygen through Regulator R-2 to the hospital when the primary ROSE discharge pressure falls below 80 psig.

4.2 For normal operation

4.2.1 Close V4, V5, V6, V7 and V8.

4.2.2 Open V1, V2 and all cylinder valves, V3A thru V3H. Open each valve mounted to each cylinder.

4.2.3 Connect either one or both low pressure sources (Primary and Secondary ROSES) to the HOBS. Normal pressure of these sources is 90 psi, and can be monitored on PI-1 and/or PI-2.

4.2.4 Connect one or more of the hospital lines to the hospitals. Oxygen pressure in the lines should be 60 psi, and can be monitored on PI-5, and adjusted using Pressure Regulator R-1.

4.3 Adjusting the Regulators

4.3.1 To adjust the regulators, make sure a pressure souce is supplied to the three regulators, R-1, R-2 and R-3. First adjust the HOBS Supply Regulator R-3 until the pressure on PI-1 reads 75 psig. Next, adjust the secondary ROSE Pressure Regulator (R-2) until the pressure on PI-1 reads 80 psig. Last, adjust the Hospital Oxygen Use Regulator R-1 until the pressure on PI-5 reads 60 psig.

5.0 DRAWINGS

The following drawings are included in this section:

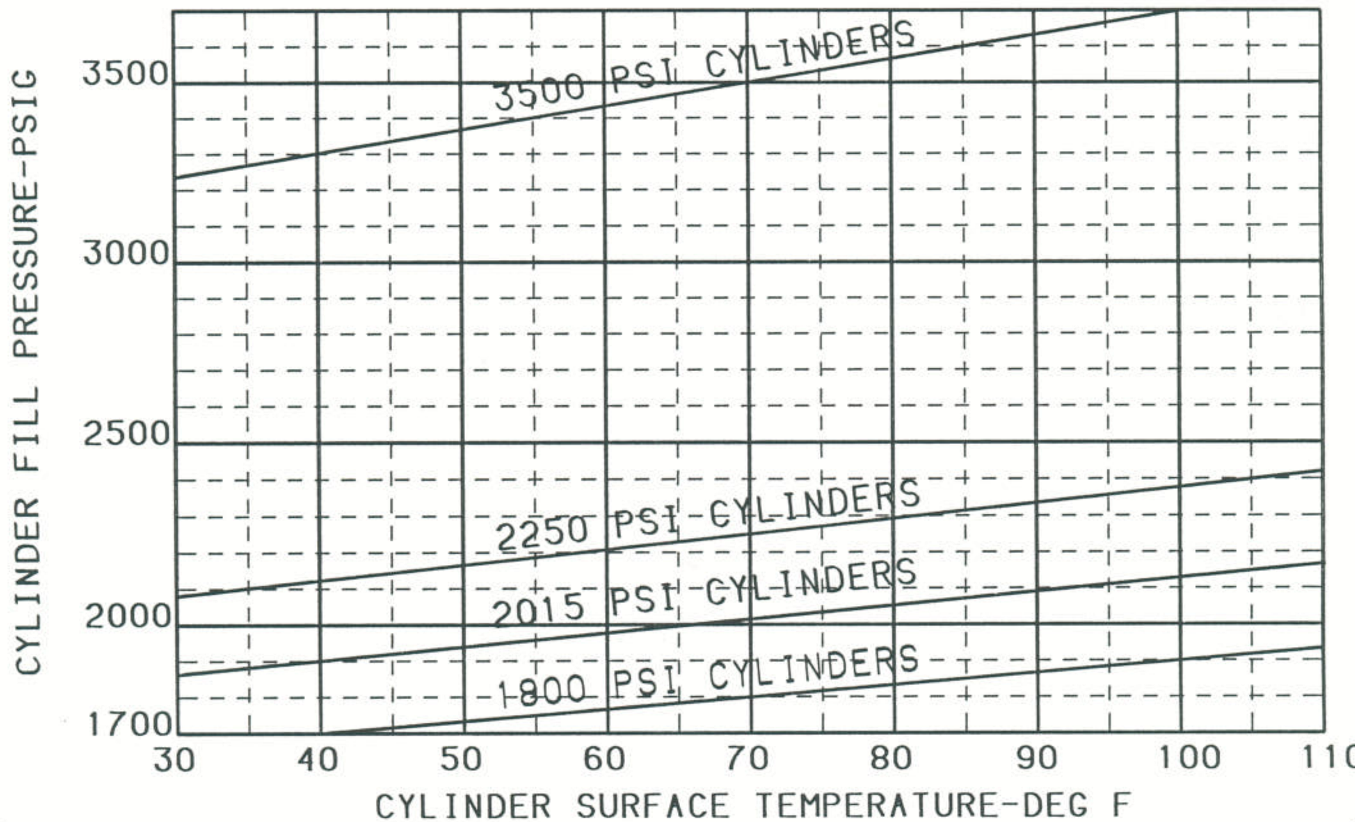
Drawing	Title
790575 /791409	Schematic, Hospital Oxygen Backup System /CFS
790574	Installation Dwg, HOBS
790570	HOBS Assy
790376	Pigtail Assy
790614	Manifold Assy - Gauge
790295	Pressure vs. Temperature Nomagram

790295

LTR	REVISIONS/DESCRIPTION	DATE	APPD
	SEE ECN		

PACIFIC CONSOLIDATED INDUSTRIES
ORANGE, CALIFORNIA, USA

CYLINDER PRESSURE VS TEMPERATURE



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE: .X ±.10 .XX ±.03 .XXX ±.010 ANGLES ± 2°	USED ON / SIMILAR TO	PACIFIC CONSOLIDATED INDUSTRIES ORANGE, CALIFORNIA, USA	
DWN R. ZARATE	TITLE CHART, CYLINDER FILLING PRESSURE VS TEMPERATURE	FSCM NO. 75906	DWG NO. 790295
CHK		SCALE —	REV
APPD		RD	PG 1 OF 1
DATE 11-17-89			

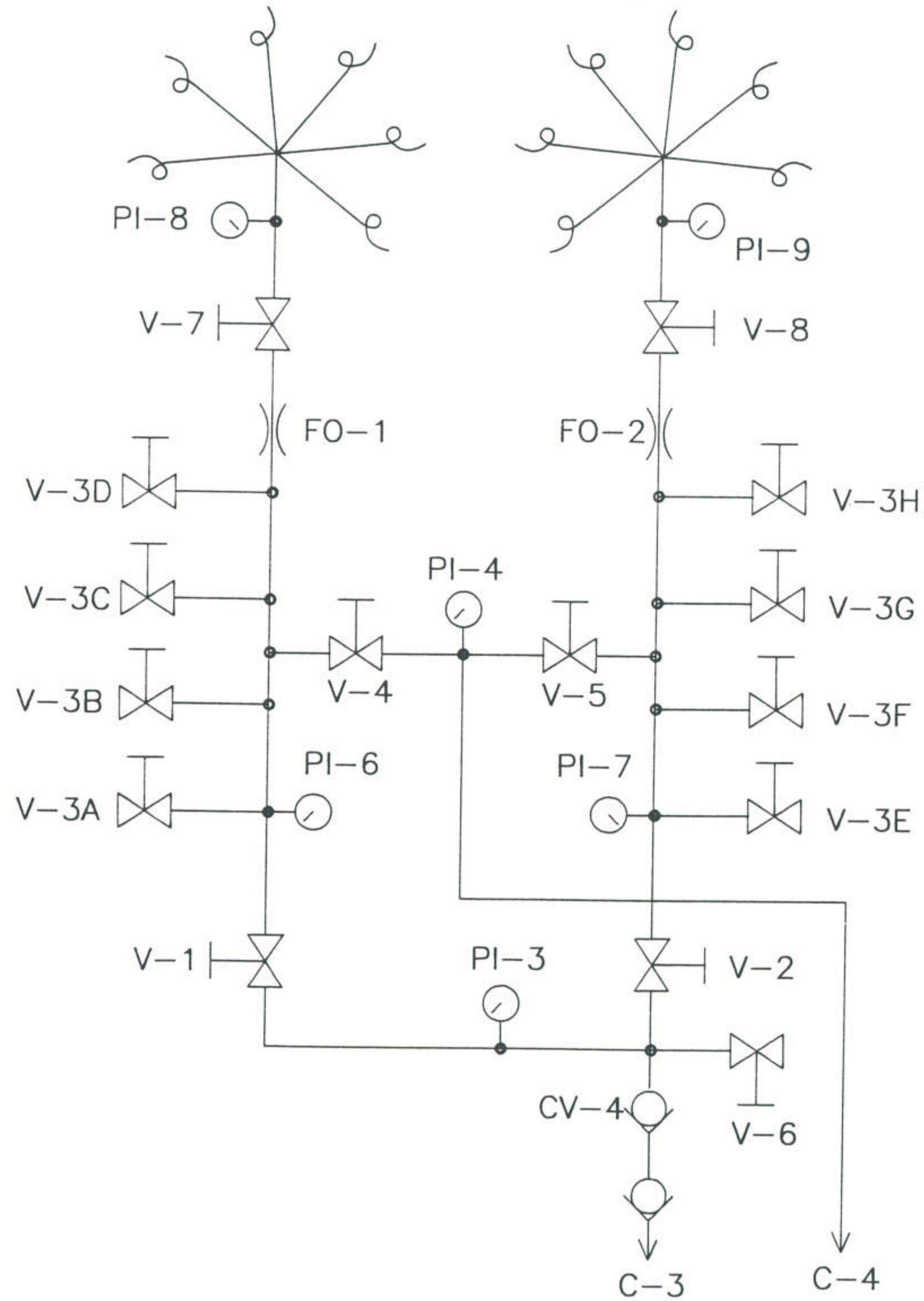
CADD

LTR	REVISIONS / DESCRIPTION	DATE	APPROVED
A	SEE ECN A	96-12-4	RU

NOTES: UNLESS OTHERWISE SPECIFIED

1. INTERPRET DRAWING IAW MIL-STD-100.

FLOW DIAGRAM



SYMBOL	DESCRIPTION
C-3 —	CONNECTION,MANIFOLD FILL-HIGH PRESSURE
C-4 —	CONNECTION,VACUUM
CV-4—	CHECK VALVE,MANIFOLD FILL
FO-1 —	FLOW ORIFICE,D-CYLINDER RACK-LEFT
FO-2 —	FLOW ORIFICE,D-CYLINDER RACK-RIGHT
PI-3 —	PRESS.IND.MANIFOLD SUPPLY (0-4000 PSI)
PI-4 —	PRESS.IND. VAC. (30 HG-15 PSI)
PI-6 —	PRESS.IND.MAN-LEFT (0-4000 PSI)
PI-7 —	PRESS.IND.MAN-RIGHT (0-4000 PSI)
PI-8 —	PRESS.IND.MAN-LEFT D-CYL.RACK (0-5000 PSI)
PI-9 —	PRESS.IND.MAN-RIGHT D-CYL.RACK(0-5000 PSI)
V-1 —	VALVE,MANIFOLD-LEFT
V-2 —	VALVE,MANIFOLD-RIGHT
V-3A-H	VALVE,CYLINDERS-HIGH PRESSURE
V-4 —	VALVE,VACUUM-LEFT
V-5 —	VALVE,VACUUM-RIGHT
V-6 —	VALVE,VENT
V-7 —	VALVE,MANIFOLD-LEFT,D-CYLINDER RACK
V-8 —	VALVE,MANIFOLD-RIGHT,D-CYLINDER RACK

QTY REQD		CAGE CODE	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ZONE	ITEM NO.
			-001	SCHEMATIC, FLOW-CFS			1

PARTS LIST

DISTRIBUTION STATEMENT: SEE PROPRIETARY RIGHTS NOTICE HEREON.

REDUCED PRINT

NEXT ASSY	USED ON
790570	790570

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACT ± ; DECIMALS .X ±.10 .XX ±.03 .XXX ±.010 ; ANGLES ± 2°
DO NOT SCALE DRAWING
DIMENSIONS & TOLERANCES PER ANSI Y14.5M-1982
SIMILAR TO | CALC WT | ACT WT

		DATE
CONTRACT NO.	U.S. ARMY	
WORK ORDER NO.	6082	
DRAWN	R.UNDERWOOD	91-1-2
CHECK'D	M.SCHROEDER	91-1-2
ENGR	R.ZARATE	91-1-15
DESIGN ACTIVITY	R.ZARATE	91-1-15

PACIFIC CONSOLIDATED INDUSTRIES
ORANGE, CALIFORNIA, USA

TITLE SCHEMATIC, FLOW, MANIFOLD ASSY-CFS

SIZE	CAGE CODE	DWG NO.	REV.
D	75906	791409	A

SCALE 1/1 | REL DATE 91-1-15 | SHEET 1 OF 1

CADYSY3 1

791409 A

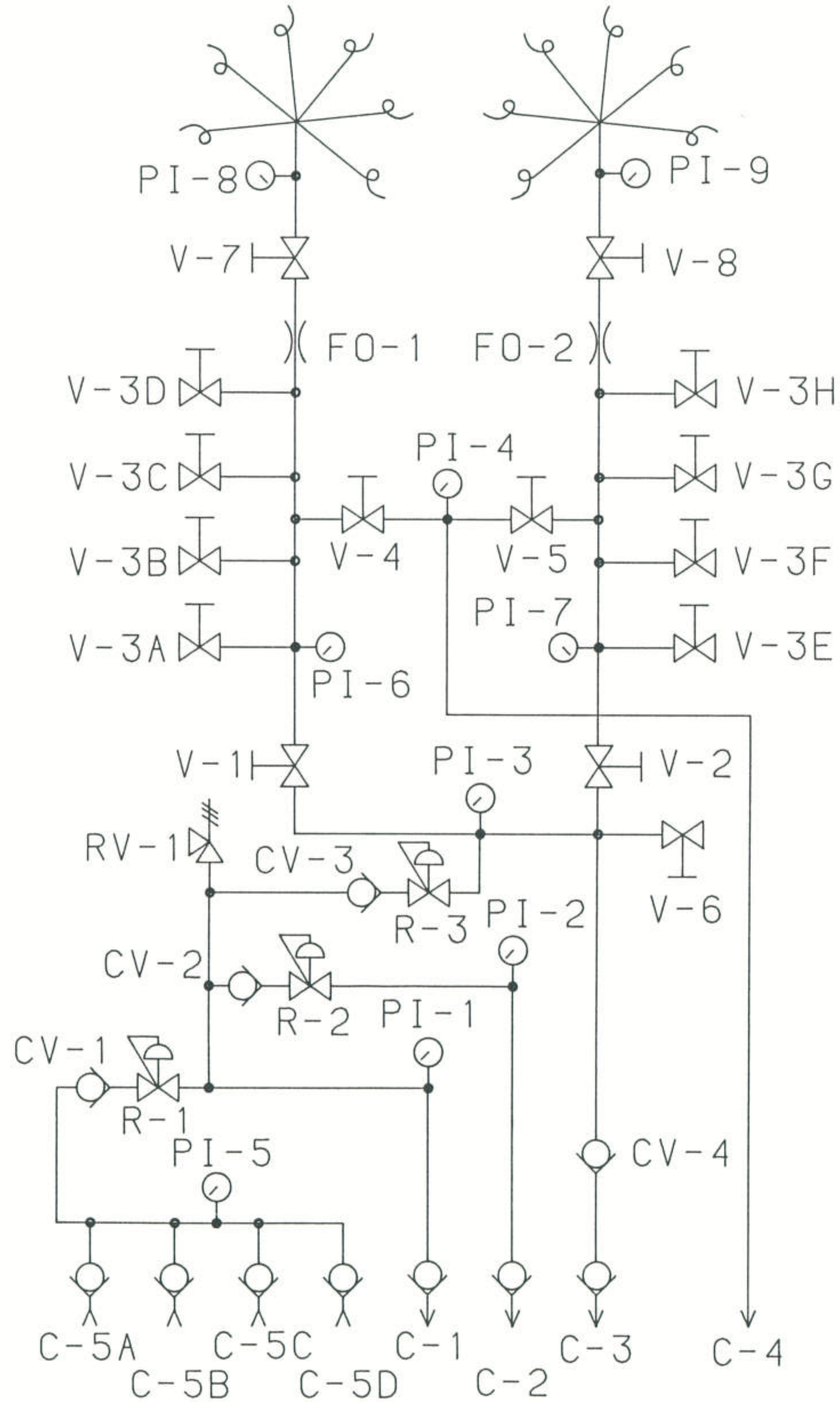
8	7	6	5	790575	4	3	2	1

LTR	REVISIONS / DESCRIPTION	DATE	APPROVED
A	SEE ECN	1-29-91	LB

NOTES: UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES.
2. IDENTIFY WITH DRAWING NO. APPL. DASH NO./ REV. LTR.

FLOW DIAGRAM



SYMBOL	DESCRIPTION
C-1	CONNECTION, PRIMARY ROSE
C-2	CONNECTION, SECONDARY ROSE
C-3	CONNECTION, HOBS FILL-HIGH PRESSURE
C-4	CONNECTION, VACUUM
C-5A-D	CONNECTION, HOSPITAL OXYGEN SUPPLY
CV-1	CHECK VALVE, PRIMARY ROSE
CV-2	CHECK VALVE, SECONDARY ROSE
CV-3	CHECK VALVE, HOBS SUPPLY
CV-4	CHECK VALVE, HOBS FILL
FO-1	FLOW ORIFICE, D-CYLINDER RACK-LEFT
FO-2	FLOW ORIFICE, D-CYLINDER RACK-RIGHT
PI-1	PRESS. IND. PRIMARY (0-200 PSI)
PI-2	PRESS. IND. SEC. ROSE (0-200 PSI)
PI-3	PRESS. IND. HOBS SUPPLY (0-4000 PSI)
PI-4	PRESS. IND. VAC. (30 HG-15 PSI)
PI-5	PRESS. IND. HOSP. O2 SUPPLY (0-200 PSI)
PI-6	PRESS. IND. MAN-LEFT (0-4000 PSI)
PI-7	PRESS. IND. MAN-RIGHT (0-4000 PSI)
PI-8	PRESS. IND. MAN-LEFT D-CYL. RACK (0-5000 PSI)
PI-9	PRESS. IND. MAN-RIGHT D-CYL. RACK (0-5000 PSI)
R-1	REGULATOR, HOSPITAL USE (60 PSI)
R-2	REGULATOR, SECONDARY ROSE (80 PSI)
R-3	REGULATOR, HOBS SUPPLY (75 PSI)
RV-1	RELIEF VALVE (200 PSI)
V-1	VALVE, MANIFOLD-LEFT
V-2	VALVE, MANIFOLD-RIGHT
V-3A-H	VALVE, CYLINDERS-HIGH PRESSURE
V-4	VALVE, VACUUM-LEFT
V-5	VALVE, VACUUM-RIGHT
V-6	VALVE, VENT
V-7	VALVE, MANIFOLD-LEFT, D-CYLINDER RACK
V-8	VALVE, MANIFOLD-RIGHT, D-CYLINDER RACK

QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ZONE	ITEM NO.
-1	75906	-001	SCHEMATIC, HOBS			1

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACT ± ; DECIMALS .X ±.10 .XX ±.03 .XXX ±.010 ; ANGLES ± 2°
DO NOT SCALE DRAWING
DIMENSIONS & TOLERANCES PER ANSI Y 14.5

CONTRACT NO. WO-555
DRAWN LUIS BOCHELEN — DATE 12-21-90
CHECKED
DESIGN
DESIGN ACTIVITY R. ZARATE — 1-15-91
CUSTOMER

PACIFIC CONSOLIDATED INDUSTRIES
ORANGE, CALIFORNIA, USA

TITLE: SCHEMATIC HOBS

SIZE	FSCM NO.	DWG NO.	REV.
D	75906	790575	A

SCALE 1/1 — REL DATE 1-15-91 — SHEET 1 OF 1

ITEM NO. REF	ALTERNATE MATERIAL OR PART NUMBER
△ ACCEPTABLE ALTERNATES	

NEXT ASSY	USED ON
APPLICATION	

SIMILAR TO — CALC WT LBS — ACT WT LBS

790575 A

8	7	6	5	4	3	2	1

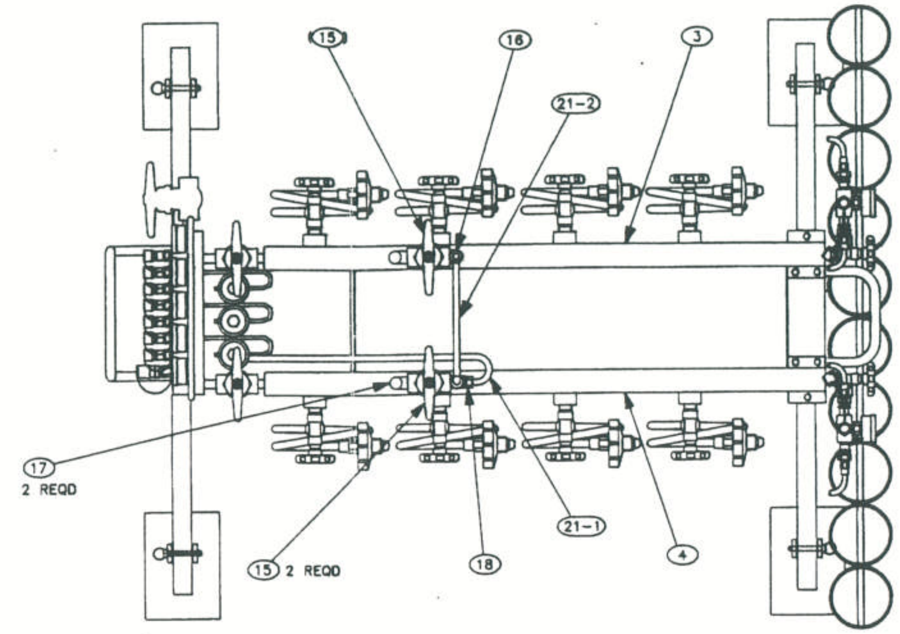
CADD

MATERIAL CUT LIST			
ITEM	IDENT	SIZE	QTY
19	21-1	24.0	1
	21-2	15.0	1

LTR	REVISIONS / DESCRIPTION	DATE	APPROVED
C	SEE ECN C	96-11-25	RU

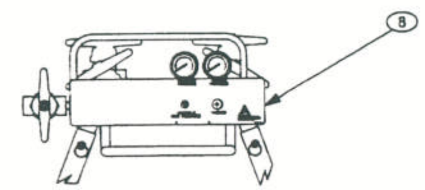
NOTES: UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES.
2. ITEM IDENTIFICATION: ETCH/ENGRAVE THE FOLLOWING MARKINGS PER MIL-STD-130:
   75906/790570-001/(APPL REV LTR)
   OR
   75906/790570-002/(APPL REV LTR)
3. ITEM 12 STORAGE BOX NOT SHOWN.
4. INTERPRET DRAWING IAW MIL-STD-100.
5. PARTS LIST PARENTHETICAL IN-HOUSE PART NUMBERS ARE FOR REFERENCE ONLY.
6. APPLY 2-3 TURNS OF TEFLON TAPE, ITEM 20, TO PIPE THREADS PRIOR TO ASSEMBLY.

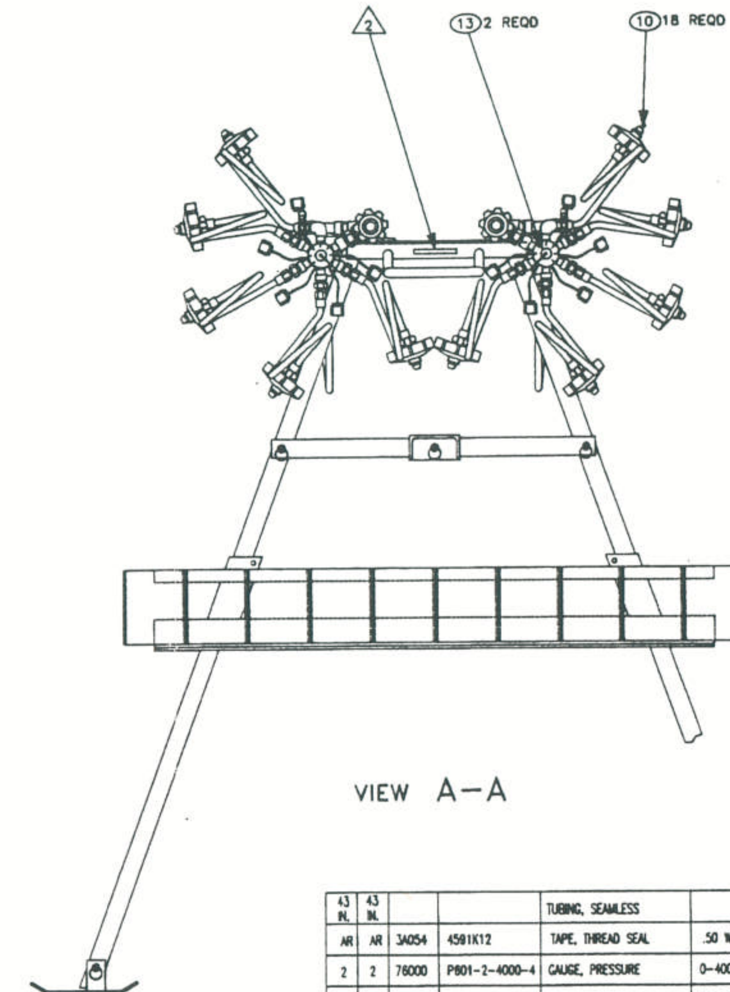


-001

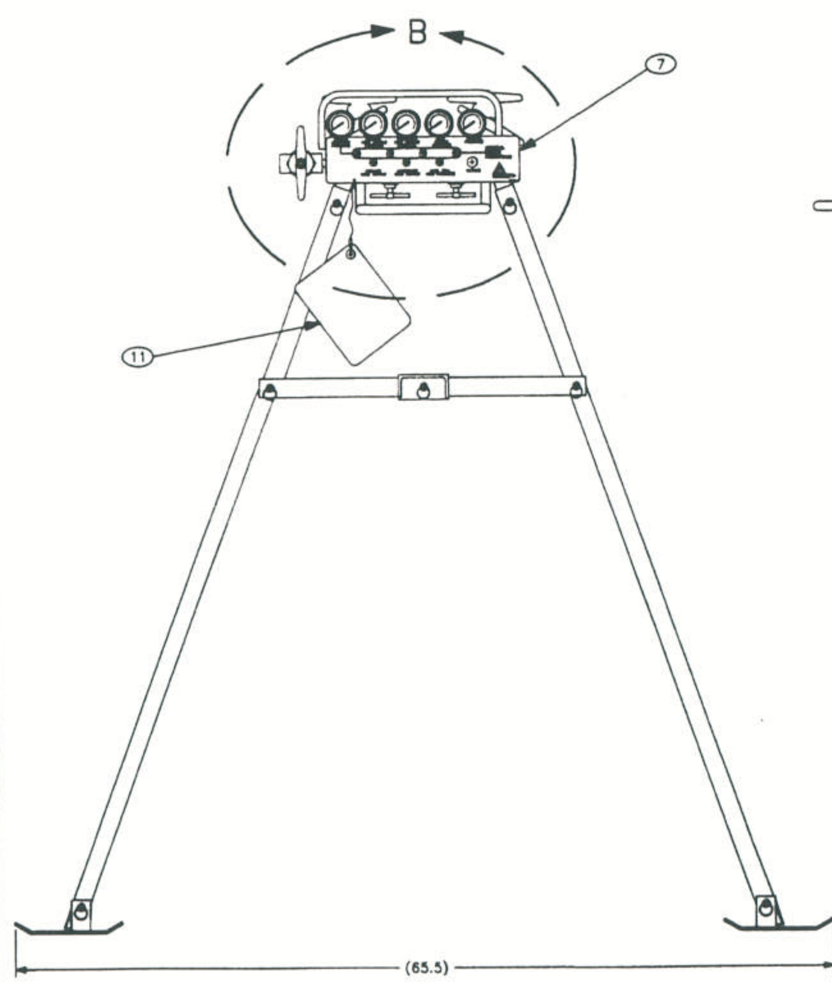
-002 -002 SAME AS -001 EXCEPT AS SHOWN

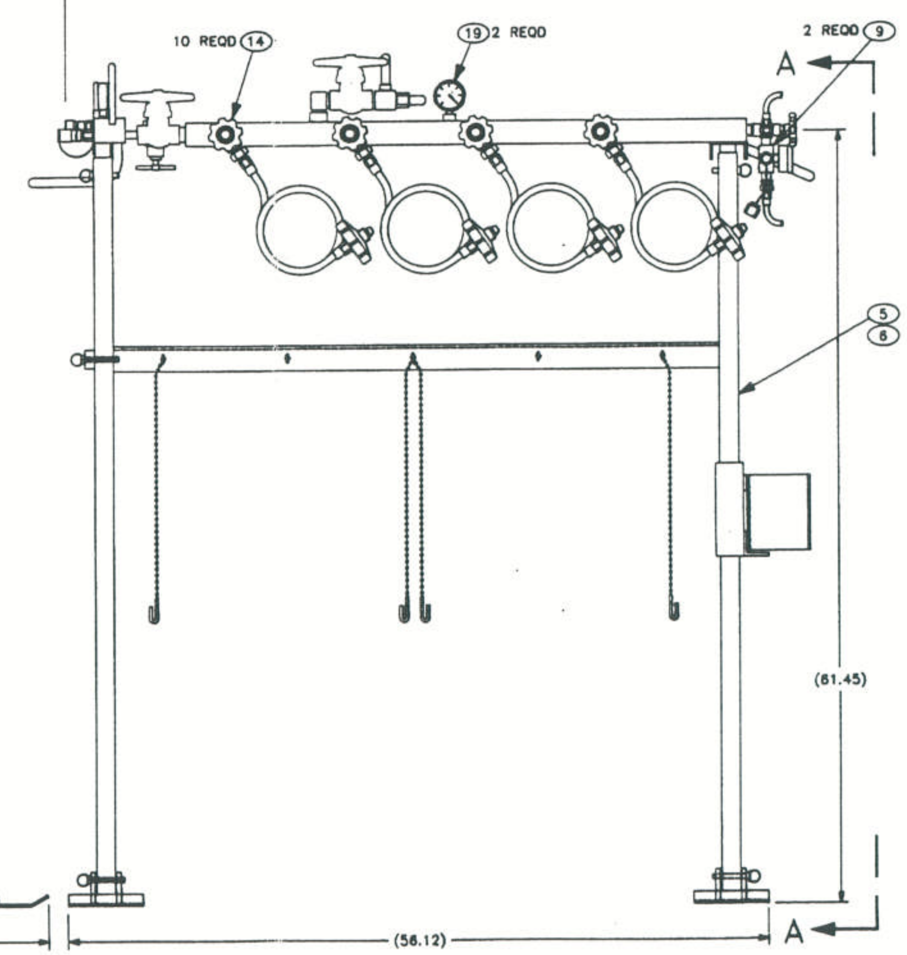


VIEW B
FOR -002



VIEW A-A





43 IN.	43 IN.			TUBING, SEAMLESS	SST (S09008-046)	2
AR	AR	3A054	4591K12	TAPE, THREAD SEAL	.50 WIDE TEFLON (W14420-050)	2
2	2	76000	P801-2-4000-4	GAUGE, PRESSURE	0-4000 .250 NPT BRASS (580302-003)	1
1	1	02570	SS-810-3-8TMT	TEE, MALE RUN	T08-P08 SST (S54140-104)	1
2	2	11649	SS-8-ME	ELBOW, MALE PIPE	P08-P08 SST (S39093-009)	1
1	1	02570	SS-810-2-8	ELBOW, MALE	T08-P08 SST (S39078-017)	1
2	2	58533	430-CM	VALVE, SHUT-OFF	.500 NPT (581528-003)	1
10	10	58533	1100X58-540	VALVE, SHUT-OFF	CGA 540 (581528-002)	1
2	2	38056	251009SW-028	GAUGE, PRESSURE	0-5000 .250 NPT CB SST (581046-005)	1
1	1		791415-001	BOX, STORAGE	(NOT SHOWN)	1
1	1		791405-001	CHART ASSY, CYLINDER		1
18	18		790376-001	PIGTAIL ASSY - CGA 540		1
2	2		790618-001	MANIFOLD, BLOCK - 7 PT		
1			790614-002	MANIFOLD ASSY - CFS		
	1		790614-001	MANIFOLD ASSY - HOBS		
1			790573-002	FRAME ASSY, CFS		
	1		790573-001	FRAME ASSY, HOBS		
1	1		790572-002	MANIFOLD, PIGTAIL-RIGHT		
1	1		790572-001	MANIFOLD, PIGTAIL-LEFT		
			-002	MANIFOLD ASSY, CFS	(CYLINDER FILL SYSTEM-MEDSOM)	
			-001	MANIFOLD ASSY, HOBS	(HOSPITAL OXYGEN BACKUP SYSTEM)	
-002 QTY REQD	-001 QTY REQD	CAGE CODE	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ZONE

PARTS LIST

DISTRIBUTION STATEMENT: SEE PROPRIETARY RIGHTS NOTICE HEREON.

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS: .X ±.19 .XX ±.03 .XXX ±.010 ANGLES ±2°
DO NOT SCALE DRAWING
DIMENSIONS & TOLERANCES PER ANSI Y14.5M-1982

FINAL
NEXT ASSY | USED ON
APPLICATION

CONTRACT NO. U.S. ARMY

M.SCHROEDER	90-12-28
R.ZARATE	91-1-15
R.ZARATE	91-1-15
R.ZARATE	91-1-15

CALC WT 170#

PACIFIC CONSOLIDATED INDUSTRIES
ORANGE, CALIFORNIA, USA

MANIFOLD ASSY, HOBS/
HIGH PRESSURE MANIFOLD ASSY

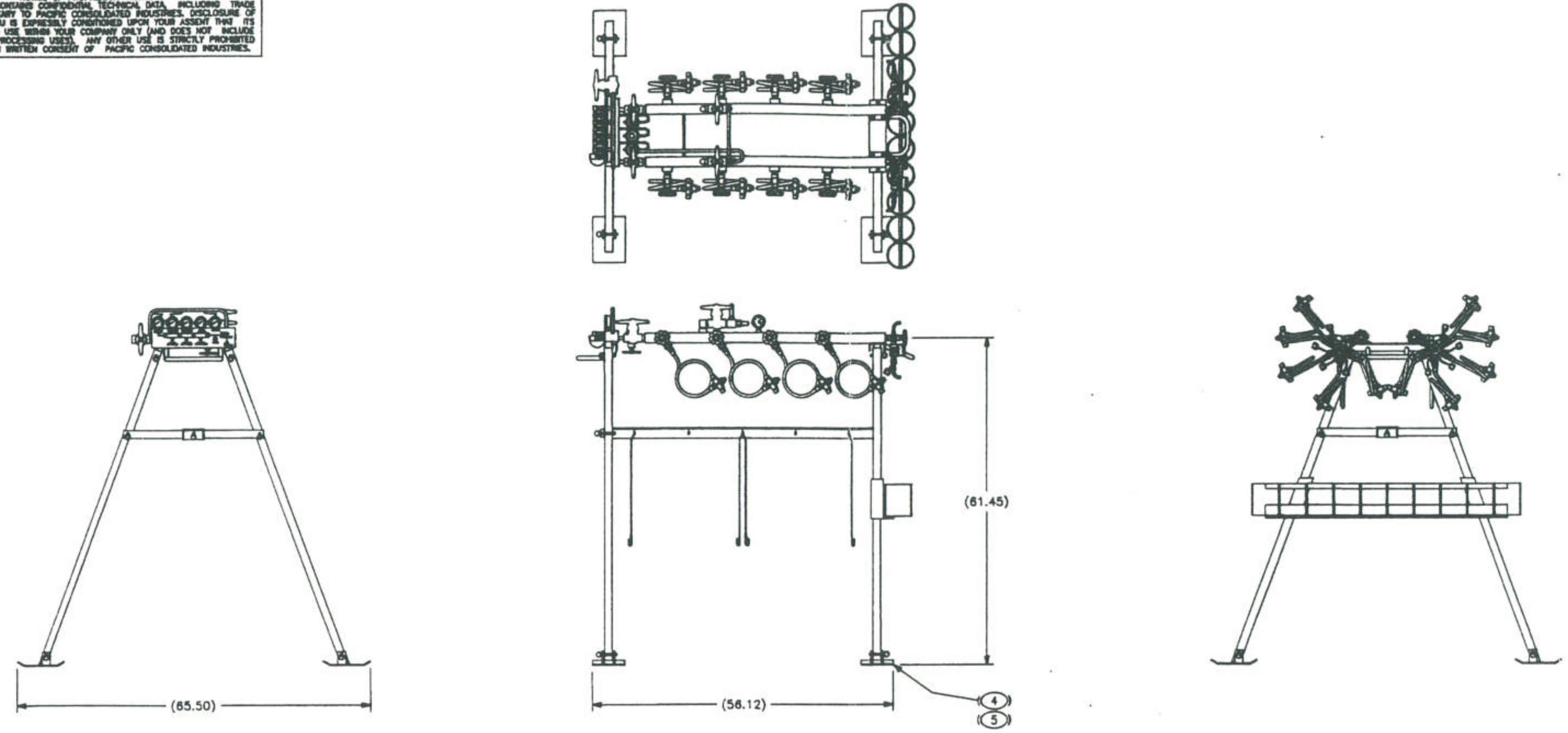
SIZE E | CAGE CODE 75906 | DWG NO. 790570
SCALE 1/5 | REL DATE 91-1-15 | SHEET 1 OF 1

CADSYS3

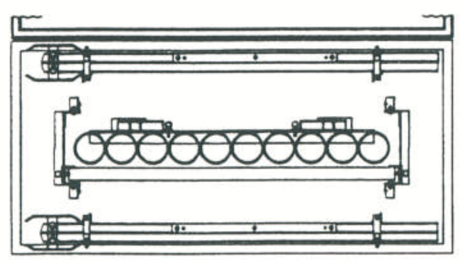
LTR	REVISIONS / DESCRIPTION	DATE	APPROVED
A	SEE ECN A	96-12-3	RU

NOTES: UNLESS OTHERWISE SPECIFIED

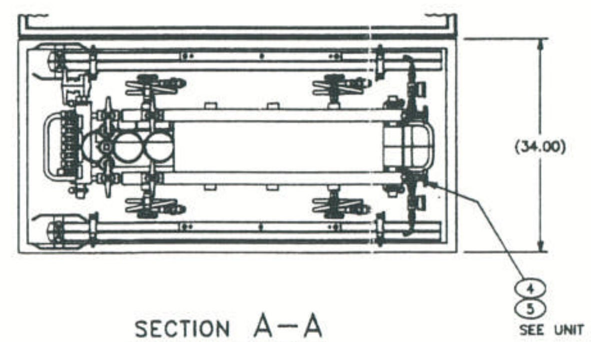
1. REMOVE ALL BURRS AND SHARP EDGES.
2. (ITEM IDENTIFICATION: IDENTIFY PER REQUIREMENTS ON DRAWING 791415).
3. INTERPRET DRAWING IAW MIL-STD-100.
4. SEE DRAWING 791420 FOR PACKING INSTRUCTIONS.



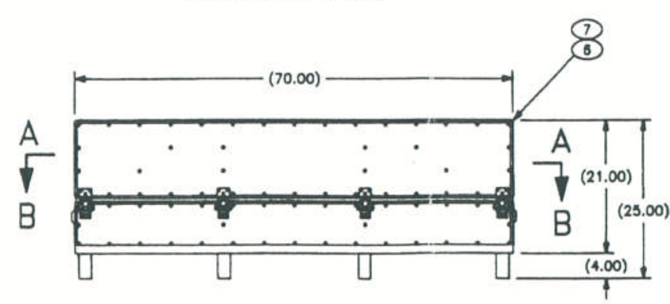
ITEM 4/ITEM 5 UNIT ASSEMBLED



SECTION B—B
(LID OPEN, WITH MANIFOLD ASSY REMOVED)



SECTION A—A
(LID OPEN, FULLY PACKED)



-001/-002 UNIT PACKED

-002 SAME AS -001 EXCEPT AS SHOWN (SEE PL)

-002 QTY REQD	-001 QTY REQD	CAGE CODE	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ZONE	ITEM NO.
							8
1			791415-002	CONTAINER ASSY-CFS			7
	1		791415-001	CONTAINER ASSY-HOBS			6
1			790570-002	MANIFOLD ASSY-CFS			5
	1		790570-001	MANIFOLD ASSY-HOBS			4
							3
			-002	INSTL-CFS			2
			-001	INSTL-HOBS			1

PARTS LIST

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DIMENSIONS & TOLERANCES PER ANSI Y14.5M-1982

FINAL
NEXT ASSY | USED ON
APPLICATION

U.S. ARMY

L.BOCHELEN	91-1-14
M.SCHROEDER	91-1-15
R.ZARATE	91-1-15
R.ZARATE	91-1-15

PACIFIC CONSOLIDATED INDUSTRIES
ORANGE, CALIFORNIA, USA

MANIFOLD INSTALLATION, HOBS / CFS

E 75906 790574 A

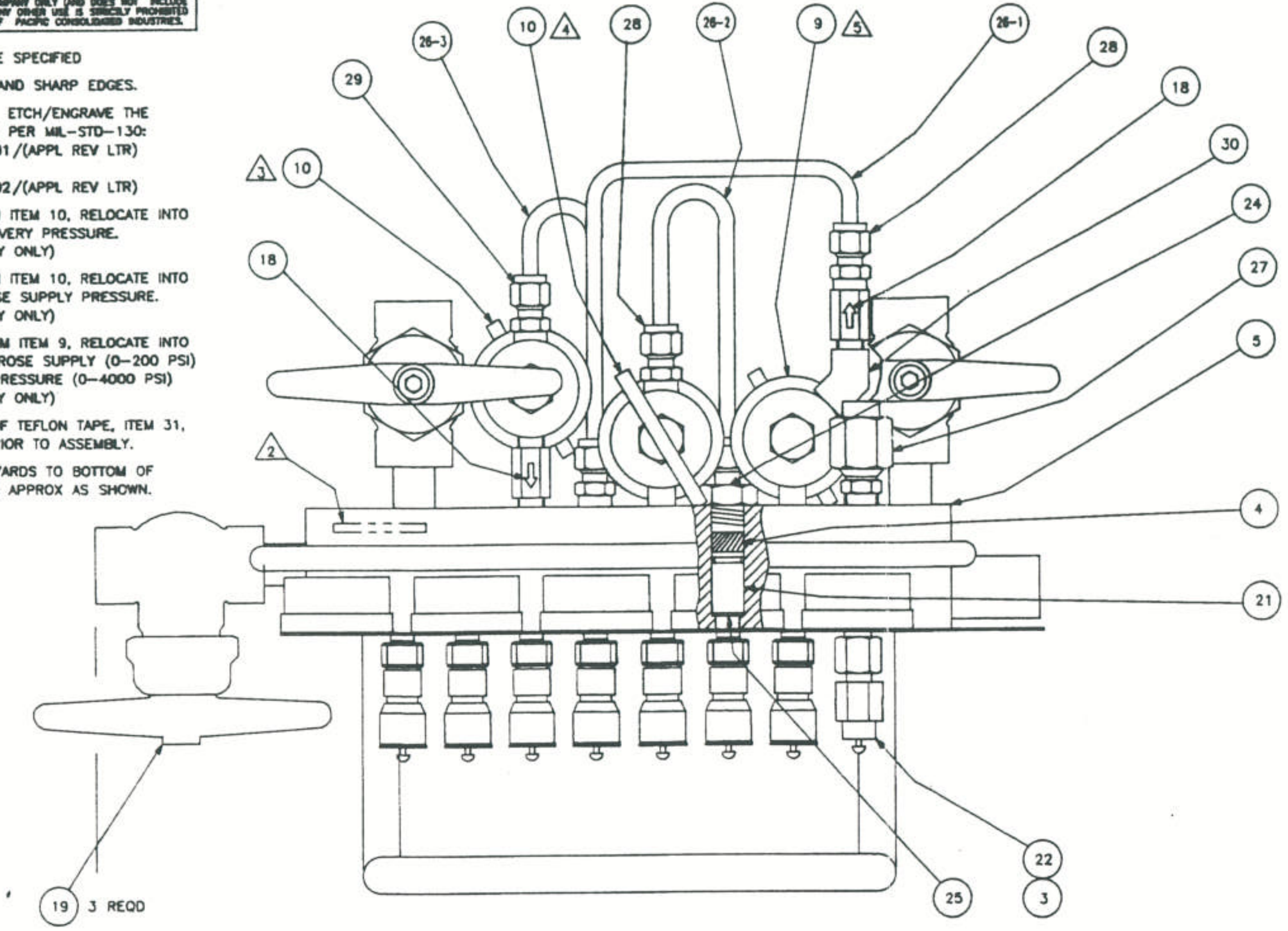
SCALE 1/10 91-1-16 SHEET 1 OF 1

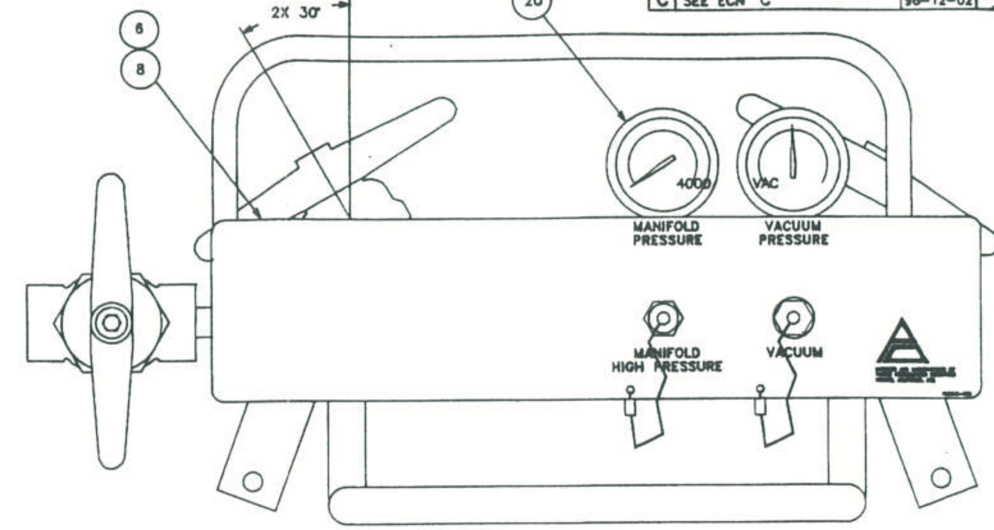
CADSYS3

LTR	REVISIONS / DESCRIPTION	DATE	APPROVED
C	SEE ECN C	96-12-02	RJ

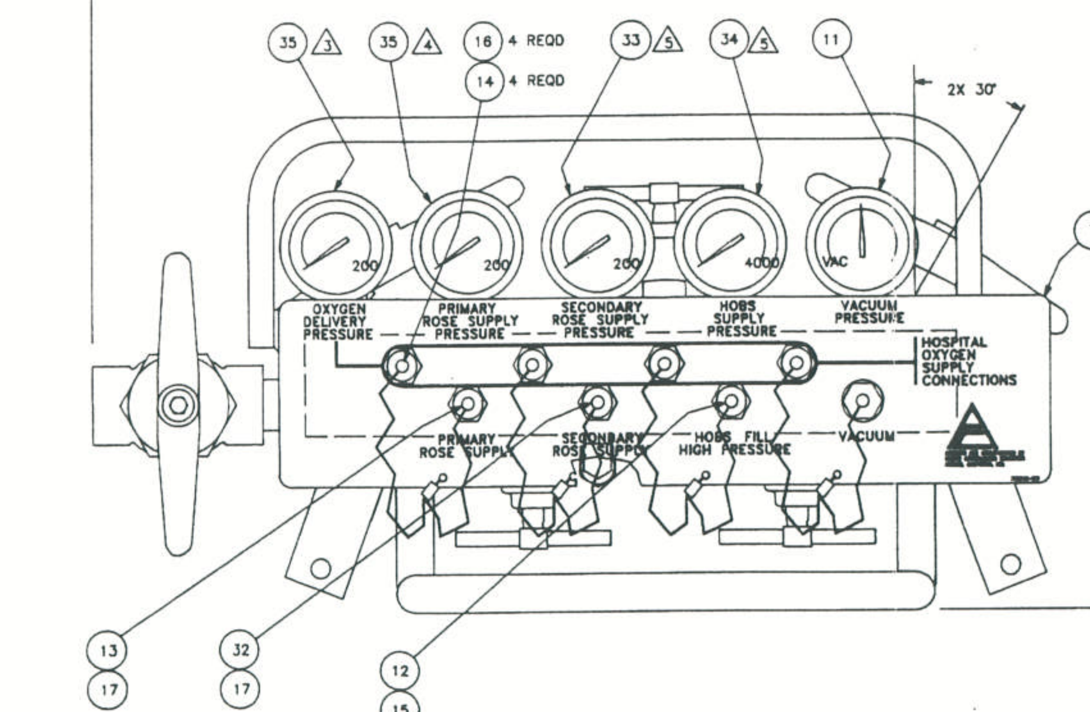
NOTES: UNLESS OTHERWISE SPECIFIED

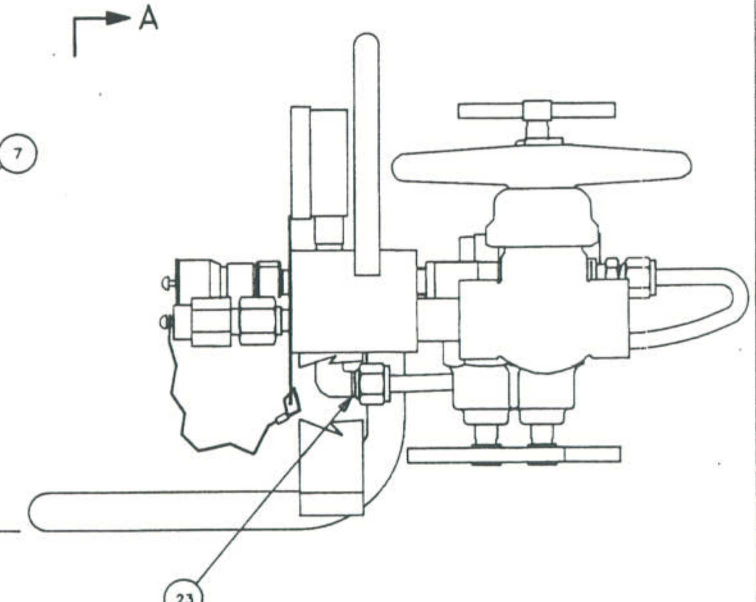
1. REMOVE ALL BURRS AND SHARP EDGES.
2. ITEM IDENTIFICATION: ETCH/ENGRAVE THE FOLLOWING MARKINGS PER MIL-STD-130:
   75906/790614-001/(APPL REV LTR)
   OR
   75906/790614-002/(APPL REV LTR)
3. REMOVE GAUGE FROM ITEM 10, RELOCATE INTO ITEM 5, OXYGEN DELIVERY PRESSURE. (FOR -001 ASSEMBLY ONLY)
4. REMOVE GAUGE FROM ITEM 10, RELOCATE INTO ITEM 5, PRIMARY ROSE SUPPLY PRESSURE. (FOR -001 ASSEMBLY ONLY)
5. REMOVE GAUGES FROM ITEM 9, RELOCATE INTO ITEM 5, SECONDARY ROSE SUPPLY (0-200 PSI) AND HOBS SUPPLY PRESSURE (0-4000 PSI) (FOR -001 ASSEMBLY ONLY)
6. APPLY 2-3 TURNS OF TEFLON TAPE, ITEM 31, TO PIPE THREADS PRIOR TO ASSEMBLY.
7. ATTACH END OF LANYARDS TO BOTTOM OF ITEM 7 OR 8 LABELS APPROX AS SHOWN.





VIEW A-A FOR -002





-001 ASSY-HOBS
-002 ASSY-CFS

MATERIAL CUT LIST

ITEM	IDENT	SIZE	QTY
26	26-1	10.0	1
	26-2	7.0	1
	26-3	6.5	1

PARTS LIST

QTY REQD -002	QTY REQD -001	CAGE CODE	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ZONE	ITEM NO.
	REF			GAUGE, PRESSURE	200 PSI PART OF ITEM 10 (FOR SPARE USE 581704-003)		35
	REF			GAUGE, PRESSURE	4000 PSI PART OF ITEM 9 (FOR SPARE USE 581704-001)		34
	REF			GAUGE, PRESSURE	200 PSI PART OF ITEM 9 (FOR SPARE USE 581704-003)		33
	1	02570	B-QC8-S-4PM	COUPLING Q.C.	(581438-038)		32
AR	AR	3A054	4591K12	TAPE,THREAD SEAL	.50 WIDE (W14420-050) TEFLON		31
	1	30780	1/4CD45-B	ELBOW, STREET 45	P04-P04 (B39075-003)		30
	3	02570	SS-600-1-4	CONNECTOR, MALE	T06-P04 (S37709-016)		29
	2	02570	SS-600-7-4	CONNECTOR,FEMALE	T06-P04 (S37707-011)		28
1	1	02570	SS-810-1-4	CONNECTOR, MALE	T08-P04 (S37709-020)		27
	23.5 IN.		S09008-027	TUBING	.375 DIA X .035W SST		26
1	1	86928	5716-83-64	WASHER,COPPER	.63 X.39 X.064 THK. (C57002-8364)		25
1	1	54938	8-P5ON-SS	PLUG,STR.THD.HEX.HD.	1/2 (S50059-008)		24
	1	02570	S-600-2-4	ELBOW,MALE	T06-P04 (S39078-012)		23
1	1	30780	8-8FTX-SS	CONNECTOR,MALE	T08-P08 (S37700-0148)		22
1	1	96948	2506-D-3-10	VALVE,CHECK	(581708-001)		21
1		76000	P601-2-0-4000 -4-1/4 LM	GAUGE,PRESSURE	0-4000 PSI 1/4 NPT BRASS (581704-001)		20
3	3	58533	430C-M	VALVE,SHUTOFF	(581528-003)		19
	2	18034	SS-CHM-4-1	VALVE,CHECK	1/4 NPT (581525-002)		18
	2	02570	B-QC8-SP	PROTECTOR,STEM CAP	(581438-033)		17
	4	02570	B-QC8-BP	PROTECTOR,BODY CAP	(581438-032)		16
1	1	02570	VY-QT2-8-DC	PROTECTOR CAP	(581438-024)		15
	4	02570	B-QC8-B-4PM	COUPLING Q.C.BODY	(581438-022)		14
	1	02570	B-QC8-D-4PM	COUPLING,Q.C.STEM	(581438-021)		13
1	1	02570	SS-QT2-8-4PM-K1	COUPLING,Q.C.	(581438-007)		12
1	1	3A054	4004K41	GAUGE	(581142-041)		11
	2	63026	L2500-250	REGULATOR,PRESSURE	0-200 (581018-003)		10
	1	63026	SR2500	REGULATOR,PRESSURE	0-4000 (581018-002)		9
1			790612-002	LABEL, PANEL, CFS			8
	1		790612-001	LABEL, PANEL, HOBS			7
1			790571-002	MANIFOLD, CFS			6
	1		790571-001	MANIFOLD, HOBS			5
1	1		790589-001	SPACER			4
1	1		789148-008	CAP			3
			-002	ASSEMBLY, CFS			2
			-001	ASSEMBLY, HOBS			1

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NEXT ASSY	USED ON
790570	790570

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
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DIMENSIONS & TOLERANCES PER ANSI Y14.5M-1982

CONTRACT NO. U.S. ARMY

DRAWN	L.BOCHELEN	91-1-15
CHECKED	M.SCHROEDER	91-1-15
ENGR	R.ZARATE	91-1-15
DESIGN ACTIVITY	R.ZARATE	91-1-15

PACIFIC CONSOLIDATED INDUSTRIES
ORANGE, CALIFORNIA, USA

MANIFOLD ASSY, GAUGE, HOBS / CFS

SIZE E | CAGE CODE 75906 | DWG NO. 790614 | REV C

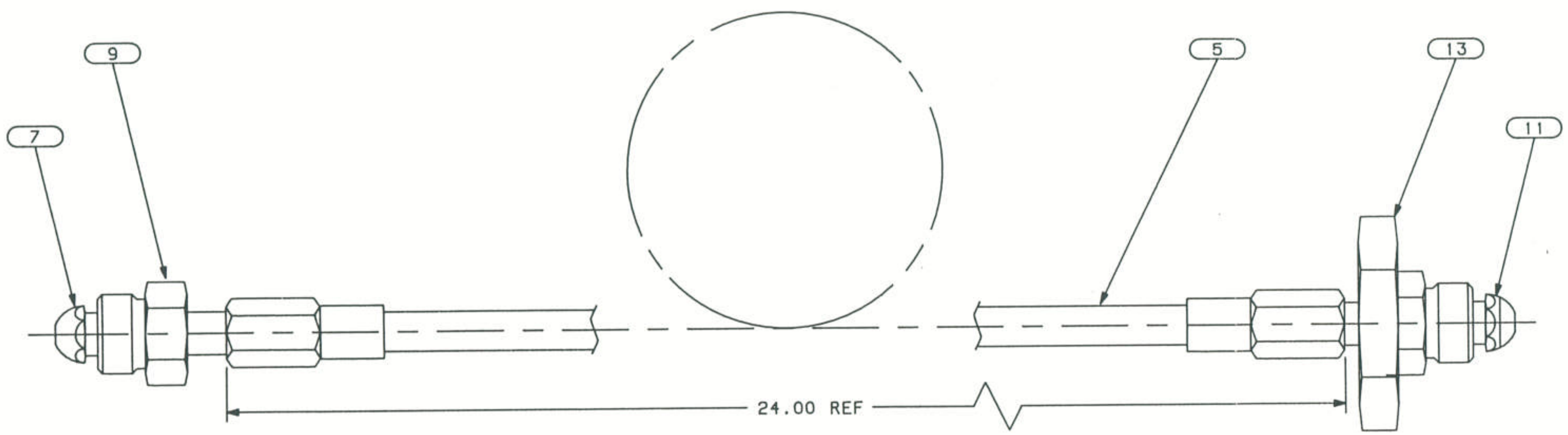
SCALE 8/10 | REL DATE 91-1-15 | SHEET 1 OF 1

CADSYS3

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

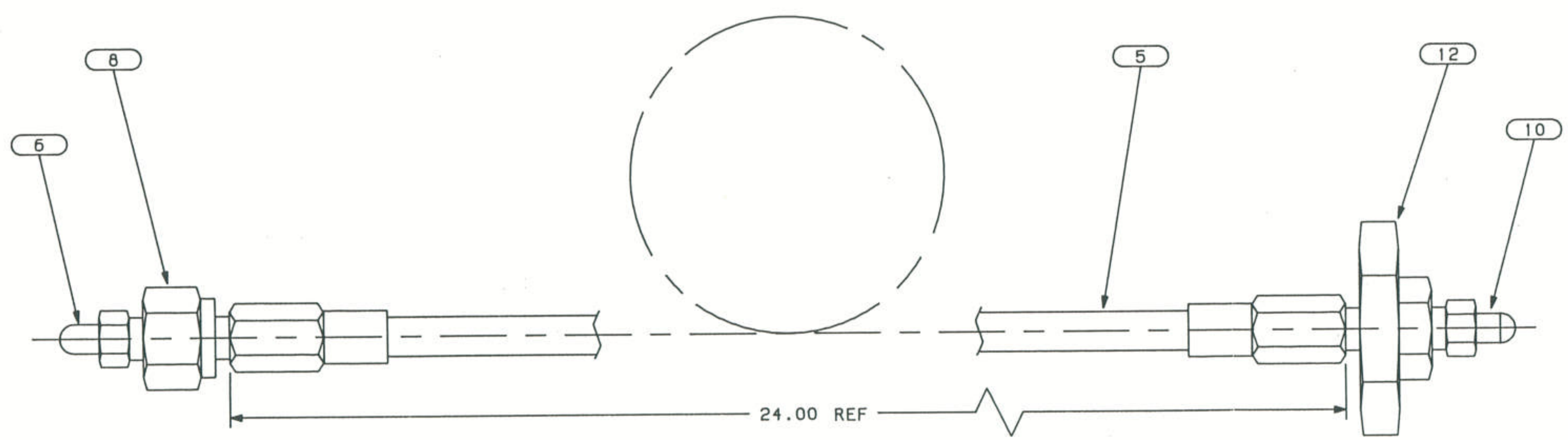
NOTES: UNLESS OTHERWISE SPECIFIED

1. REMOVE BURRS AND BREAK SHARP EDGES.
2. IDENTIFY WITH PN 790376 -APPL DASH NO./APPL REV LTR.
3. WRAP PIPE THREADS WITH ITEM 14 SEAL TAPE PRIOR TO ASSY.
4. FOR -1 PIGTAIL ASSY, CLEAN FOR OXYGEN SERVICE PER CPS 1003. BAG & SEAL TO MAINTAIN CLEANLINESS.
5. FOR -2 PIGTAIL ASSY, CLEAN FOR NITROGEN SERVICE. BAG & SEAL TO MAINTAIN CLEANLINESS.



DETAIL -2 PIGTAIL ASSY

-GN2 CGA580



DETAIL -1 PIGTAIL ASSY

-GO2 CGA540

-2	-1	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ZONE	ITEM NO.
							15
AR	AR		W14420-050	TAPE,THD SEAL	.50 WIDE TEFLON		14
1		0A1K0	692-P	NUT,HAND	CGA580 581516-013		13
	1	0A1K0	662-P	NUT,HAND	CGA540 581516-011		12
1		0A1K0	615-3T	NIPPLE,SOFT	CGA580 -P04 X3.00LG 581516-014		11
	1	0A1K0	663	NIPPLE,SOFT	CGA540 -P04 X2.50LG 581516-012		10
1		0A1K0	92	NUT	CGA580 581516-015		9
	1	0A1K0	62	NUT	CGA540 581516-007		8
1		0A1K0	15-3	NIPPLE	CGA580 -P04 X3.00LG 581516-016		7
	1	0A1K0	63	NIPPLE	CGA540 -P04 X2.06LG 581516-008		6
1	1	0A1K0	PF-4SS-24	HOSE ASSY,HP	P04FEMX2 X24LG 581516-010		5
							4
							3
		75906	-2	PIGTAIL ASSY	-GN2 CGA580		2
		75906	-1	PIGTAIL ASSY	-GO2 CGA540		1
QTY REQD							

LIST OF MATERIAL

ITEM NO. REF	ALTERNATE MATERIAL OR PART NUMBER
△	ACCEPTABLE ALTERNATES

790379	ASU SYST
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACT ± DECIMALS .X ±.10 .XX ±.03 .XXX ±.010 ANGLES ±2°
DO NOT SCALE DRAWING
DIMENSIONS & TOLERANCES PER ANSI Y 14.5
SIMILAR TO | CALC WT 1.3# | ACT WT

CONTRACT NO. WO-427
DRAWN R.UNDERWOOD DATE 3-9-90
CHECKED
DESIGN
DESIGN ACTIVITY R.ZARATE 3-9-90
CUSTOMER

PACIFIC CONSOLIDATED INDUSTRIES
ORANGE, CALIFORNIA, USA

TITLE PIGTAIL ASSY, CHARGE MANIFOLD-GO2/GN2

SIZE D | FSCM NO. 75906 | DWG NO. 790376 | REV.
SCALE 1/1 | REL DATE 3-9-90 | SHEET 1 OF 1

790376

CGA PAMPHLET G-4.1

CLEANING EQUIPMENT FOR OXYGEN SERVICE

COMPRESSED GAS ASSOCIATION, INC.
NEW YORK, NEW YORK

PLEASE NOTE:

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This document is subject to periodic review and users are cautioned to obtain the latest edition Comments and suggestions are invited from all users for consideration by the Association in connection with such review; any such comments or suggestions will be fully reviewed by the Association after giving the party, upon request, a reasonable opportunity to be heard.

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CONTENTS

CONTENTS (Continued)

1. SCOPE

The cleaning methods described in this pamphlet are intended for cleaning equipment used in the production, storage, distribution and use of liquid and gaseous oxygen. Examples of such equipment (illustrative of the primary intent of this publication) are: stationary storage tanks, trucks and tank cars; pressure vessels such as heat exchangers and rectification columns; and associated piping, valves and instrumentation. The cleaning methods, however, are not limited to the above equipment and with proper consideration or modification may be utilized in cleaning other oxygen service equipment such as cylinders, cylinder valves, regulators, welding torches, pipelines, compressor and pumps.(1)

2. OBJECTIVES

Oxygen equipment and systems, including all components and parts thereof, must be adequately cleaned to remove harmful contamination prior to the introduction of oxygen. Harmful contamination would include both organic and inorganic materials such as oils, greases, paper, fiber, rags, wood pieces, solvents, weld slag dirt and sand which if not removed could cause a combustion reaction in an oxygen atmosphere or result in an unacceptable product purity.

This pamphlet presents methods for cleaning oxygen service equipment. When properly used, these cleaning methods and subsequent inspections will result in the degree of cleanliness required for the safe operation of oxygen service equipment and the necessary product purity required in CGA Commodity Specification for Oxygen, Pamphlet G-4.3. Suggested levels of contamination and ways of determining if a component or system is sufficiently clean to be used in oxygen service are given along with procedures for keeping such equipment clean before being placed in service.

Cleaning a component or system for oxygen service involves the removal of combustible contaminants including the surface residue from manufacturing, hot work, and assembly operations, as well as the removal of all cleaning agents and the prevention of recontamination before final assembly, installation and use. These cleaning agents and contaminants include solvents, acids, alkalies, water, moisture, corrosion products, non-compatible thread lubricants, filings, dirt, scale, slag, weld splatter, organic material (such as oil, grease, crayon and paint) lint and other foreign materials.

The removal of injurious contaminants can be accomplished by pre-cleaning all parts and maintaining this condition during construction, by completely cleaning the system after construction, or by a combination of the two.

3. PLANNING REQUIREMENTS

3.1 Supervision. An individual skilled in the techniques required for oxygen service cleaning shall be responsible for monitoring the cleaning operation and determining if a component or system is clean so that it can function in an oxygen environment. Where piping systems with multiple branches are involved it is of paramount importance that the cleaning procedures be well established, suitably integrated with the sequence of construction operations, and precisely followed since it may be neither practical nor possible to inspect such a system completely for cleanliness after construction and final cleaning.

3.2 Selecting Procedures

3.2.1 In order to decide on the most practical method of cleaning, inspecting, and testing, it is first desirable to estimate the nature, possible location, and degree of contamination. In addition, the arrangement of passages must be studied so that cleaning, washing, or draining practices can be adjusted to make sure that dead end passages and possible traps are adequately cleaned.

3.2.2 The cleaning procedure selected, which includes removal of the cleaning agent, will depend on several factors such as the following:

(a) The nature of the contaminants.

(b) The location and degree of contamination.

(c) The arrangement of passages with respect to their ability to be flushed and drained.

(d) The effectiveness of the cleaning agent in removing the contaminants.

(e) The compatibility of the cleaning agent with the contaminants, metals and material involved.

(f) The availability and cost of cleaning agents and cleaning methods, the availability of personnel experienced in handling these materials.

---

(1) CGA Pamphlet C-10, "Recommendations for Changes of Service for Compressed Gas Cylinders", includes the conversion of cylinders to oxygen service. Where the requirements for this convrsion differ from the recommendations of CGA Pamphlet C-4.1, the recommendations of CGA C-10 should take precedence.

(g) The speed and effectiveness of cleaning and the desired level of cleanliness.

3.2.3 A list of typical cleaning procedures would include:

(a) Steam cleaning (including hot water and detergents).
(b) Vapor degreasing.
(c) Solvent washing (including ultrasonics).
(d) Alkaline (caustic) washing.
(e) Acid cleaning.
(f) Mechanical cleaning (blast cleaning, wire brushing, etc.).
(g) Purging.

3.2.4 A detailed cleaning procedure in accordance with the instructions of the manufacturer of the cleaning agent should be specified to the satisfaction of both the manufacturer and the purchaser of the oxygen equipment and followed throughout the project.

4. PRECLEANING

Prior to cleaning, component material not compatible with the cleaning agent shall be removed or isolated. Gross amounts of foreign aterial such as scale, dirt, grit, solid objects d hydrocarbons shall be removed. Removal may be accomplished by grinding, wire brushing, blast cleaning, sweeping, vacuuming, swabbing, etc.

5. STEAM OR HOT WATER CLEANING

Steam or hot water cleaning may be described as the use of steam or hot water propelled through a nozzle or sprayhead and usually assisted by a detergent to remove contaminants such as dirt, oil and loose scale.

5.1 Materials. The steam or hot water should be clean and oil-free. In most steam or hot water cleaning operations, a detergent solution is combined with the steam or hot water to provide an acceptable level of final cleanliness. The detergent selected shall be suitable for the contaminants involved and shall also be compatible with the surfaces being cleaned.

5.2 Steam Cleaning

5.2.1 Equipment. The equipment used may consist of a steam and water supply, a length of hose, and a steam lance with or without a spray nozzle.

5.2.2 Steam Cleaning Procedure. Either .nt steam or steam from a portable steam generator can be used. If a steam lance is used, the detergent solution may enter the steam gun by venturi action and mix with the steam. Steam removes oils, greases and soaps by first "thinning" them with heat. Dispersion and emulsification of the oils then occur followed by dilution with the condensed steam. The system should provide control over the steam, water, and detergent flows so that full effect of the detergent's chemical action, the heat effect of the steam, and the "abrasive" action of the pressure jet is attained for maximum cleaning efficiency.

If the steam is clean and free of organic material, a secondary cleaning operation with a solvent or alkaline degreaser may not be required in cases where the initial contamination is not heavy or is readily removed with steam.

5.3 Hot Water Cleaning

5.3.1 Equipment. Cleaning with a hot detergent solution may utilize a spray system or a cleaning vat with suitable agitation of the solution or the parts.

5.3.2 Hot Water Cleaning Procedure. Hot detergent solution cleaning can be used where a steam temperature is not necessary to free and fluidize contaminants. Proper consideration shall be given to the size, shape, and the number of parts to be cleaned so as to assure adequate contact between the surfaces to be cleaned and the solution. The solution temperature should be in accordance with the recommendation of the manufacturer of the cleaning agent.

5.4 Removal of Cleaning Agents. Most detergents are water soluble and are best removed by prompt flushing with sufficient quantities of hot or cold clean water as appropriate before the cleaning agents have time to precipitate. The equipment is then dried by purging with dry oil-free air or nitrogen which may be heated to shorten the drying time.

6. CAUSTIC CLEANING

Caustic cleaning is described as cleaning with solutions of high alkalinity for the removal of heavy or tenacious surface contamination followed by a rinsing operation.

6.1 Materials. There are many effective cleaning materials available for caustic washing. They are basically alkalies and are water soluble, non-flammable and may be harmful in contact with the skin or if swallowed. The

cleaning agents should be chosen so that they do not react chemically with the metal being cleaned.

The water that is used for rinsing should be free of oil and other hydrocarbons and should contain no particles larger than those acceptable on the cleaned surface.

Filtration may be required. It may be desirable to analyze the water to determine the type and quantity of impurities. Some impurities may cause undesirable products or reactions with the particular caustic cleaner used.

6.2 Caustic Washing Procedure. The cleaning solution can be applied by spraying, immersion flushing, or hand swabbing. Spraying works well, but requires a method whereby the cleaning solution reaches all areas of the surface. It is also desirable to have provisions for draining the solution faster than it is introduced to avoid accumulation.

Immersion or flushing should be total rather than partial as the solution tends to dry on the surface that is exposed to air.

Hand swabbed surfaces should be rinsed before the cleaning solution dries.

Generally, cleaning solutions perform better when warm. Depending upon the particular solution, this temperature will be in the range of 100 F to 180 F (38 C to 82 C).

The cleaning solution can be reused until it is too weak or too contaminated as determined by pH or concentration analysis. Both decrease as the solution weakens. Experience will establish a contaminant level above which a surface could not be acceptably cleaned.

6.3 Rinsing. The cleaning accomplished is only as good as the rinsing job. All the contaminants may be held in suspension in the cleaning solution. However, if the cleaning solution is not completely flushed from the surface being cleaned, the contaminant in any remaining solution will redeposit on the surface during the drying operation. The surface must never be allowed to dry between the cleaning phase and the rinsing phase as then all of the film or residue will not be removed.

Frequently some type of agitation during rinsing is required. This may be by mechanical brushing, fluid impingement, agitation of the parts being cleaned, etc.

The water rinse is often warm to help remove the cleaning solution and aid in the drying process. A method of determining when the rinsing is complete is to monitor the pH of the outlet rinse water. The pH approaches that of the original rinse water as the rinsing progresses.

6.4 Drying. If drying is not completed with the residual heat in the metal, it can be completed with dry oil-free air or nitrogen. If it is desirable that the equipment be maintained in a dry atmosphere before installation or use, the dew point of the contained atmosphere should not be above —30 F (—34 C).

7. ACID CLEANING

This cleaning procedure removes oxides and other contaminants by immersion in a suitable acid solution, usually at room temperature.

7.1 Material. The type of cleaning agent selected will depend, in most cases, on the material to be cleaned. The following general guide can be followed:

(a) Phosphoric acid base cleaning agents can be used for all metals. These agents will remove oxides, light rust, light soils, and fluxes.

(b) Hydrochloric acid base cleaning agents are recommended for carbon and low alloy steels only. These agents will remove rust, scale, and oxide coatings and will strip chromium, zinc and cadmium platings. Certain acidic solutions including hydrochloric or nitric acids should contain an inhibitor to prevent harmful attacks on base metals. Hydrochloric acid should not be used on stainless steel since it may cause stress corrosion.

(c) Chromic acid base cleaning agents and nitric acid base cleaning agents are recommended for aluminum and copper and their alloys. These agents are not true cleaning agents but are used for deoxidizing, brightening and for removing black smut which forms during cleaning with an alkaline solution. Some agents are available as liquids and others as powders and are mixed in concentrations of 5% to 50% in water, depending on the cleaning agent and the amount of oxide or scale to be removed.

7.2 Equipment. A storage or immersion tank, acid resistant recirculation pump and associated piping and valving compatible with the acid solution are required.

7.3 Cleaning Procedure. Common methods of applying acid cleaning agents used for cleaning metals are:

(a) Large areas may be flushed with an appropriate acid solution.

(b) Small parts may be immersed and scrubbed, or agitated in the solution.

CAUTION: Acid cleaning agents should not be used unless their application and performance are known or are discussed with the cleaning agent manufacturer. The manufacturer's recommendations regarding concentration and temperature should be followed for safe handling of the cleaning agent.

7.4 Rinsing. Rinse thoroughly with cold water. Rinsing must begin as soon as practicable after cleaning to prevent excessive attack on the material being cleaned by the acid cleaning solution.

If there is a chance of any cleaning solution becoming trapped in the equipment being cleaned, a dilute alkaline neutralizing solution can be applied, followed by water rinsing.

7.5 Drying. If drying is not completed with the residual heat in the metal, it can be completed with dry oil-free air or nitrogen. If it s desirable that the equipment be maintained in a dry atmosphere before installation or use, the dew point of the contained atmosphere should not be above —30 F (—34 C).

8. SOLVENT WASHING

8.1 Solvent Washing. Solvent washing may be described as the removal of organic contaminants from the surface to be cleaned by the use of chlorinated hydrocarbons or other suitable solvents.

8.2 Ultrasonic Cleaning. Ultrasonic cleaning may be described as the loosening of oil and grease or other contamination from metal surface by the immersion of parts in a solvent or detergent solution in the presence of high frequency vibrational energy.

8.3 Materials. The solvents frequently used are methylene chloride; refrigerant 11; perchloroethylene; 1,1,1,-trichlorethane (methyl chloroform); and trichloroethylene. Refer to Section 13.2 for additional precautions. Carbon tetrachloride shall not be used because of its high toxicity, i.e. its low threshold limit value (TLV). Trichloroethylene should be used only if absolutely necessary because it is 3.5 times as toxic as methylchloroform.

The boiling points, freezing points, toxicity (threshold limit values) and Kauri-Butenol numbers are listed in Table 1.

8.4 Washing Equipment. Washing equipment may consist of a recirculating system for the

TABLE 1
CHEMICAL AND PHYSICAL PROPERTIES OF CLEANING SOLVENTS

Solvent	Formula	Molecular Weight	Boiling Point (°F)	Freezing Point (°F)	Density at 68F (Lb/Ft³)	Latent Heat of Vaporization at Boiling Pt. (Btu/lb)	Evaporation Rate (Ether=100)	TLV(1) (ppm)	Residue Weight (%)	Kauri-Butanol Number(2) at 77F
1,1,1 Trichloroethane (Methyl Chloroform)	$C_2H_3Cl_3$	133.42	161.8	−58	82.1 (77F)	95.4	37	350	0.001	130
Methylene Chloride	CH_2Cl_2	84.94	104.2	−142.1	83.37	141.7	62	100	0.00075	109
Perchloroethylene	C_2Cl_4	165.85	250.2	−8.2	101.5	90.0	12	100	0.001	88
Refrigerant 11 (Fluorotrichloromethane)	CCl_3F	137.4	74.8	−168	92.7 (70F)	78.31	81	1000	0.001	60
Trichloroethylene(3)	C_2HCl_3	131.40	188.6	−122.8	91.42	103.0	30	100	0.0005	130

(1) Threshold Limit Values (time weighted average) adopted by American Conference of Governmental Industrial Hygienists, 1975.
The higher the Kauri-Butanol Number, the greater the solvent action.
(3) Trichloroethylene has a listed flash point of 90F (32C) and flammable limits of 12% to 40% in air.

solvent or a closed container for immersing parts.

Auxiliary control and test equipment might include the following: space heaters, halogen detectors, thermometers, a utility container, funnel and strainer, an Imhoff cone, dry oil free air or nitrogen and syphon pump.

For ultrasonic cleaning, a high frequency sound generator and container is substituted for the recirculation system.

CAUTION: Some plastic tubing including polyvinylchloride (PVC) may have its plasticizer extracted by the solvent and deposited on the surface being cleaned. Rubber and neoprene tubing should not be used with these solvents for the same reason when cleaning oxygen equipment. Nylon and polytetrafluoroethylene (PTFE) tubing are satisfactory with the frequently used solvents.

8.5 Washing Procedure. A sample of new wash solvent should be taken for control purposes when required. Circulate the wash solvent through the equipment for a predetermined period. The desired cleanliness level can be determined by comparing the used solvent with new solvent. A vessel can be considered clean when no distinct color difference exists between the two samples. Additional washings with new solvent may be required to obtain the desired level of cleanliness. Then drain the solvent into a container and ensure that all solvent has been removed from the equipment by using such techniques as temperature and concentration monitoring of the exit purge gas. Immersion wash procedures may be utilized if practical.

If solvent monitoring is desired, measure the used solvent collected, take a representative sample of the solvent and determine its contaminant level, correcting for the amount of contaminant in the original solvent.

The solvent shall be discarded or reclaimed when the cleaning operation does not yield acceptably cleaned surfaces. A useful guide for this determination is when the solvent is discolored more than new solvent. Where standards are considered necessary, ASTM standard D-2108-71 "Color of Halogenated Organic Solvents and Their Admixtures" for guidance.

CAUTION: Use proper solvent transfer containers (precleaned glass or metal) with no seals that can be dissolved by the solvent.

8.6 Removal of Solvents. After the oil and grease contaminants have been removed or dissolved and the solvent drained, blow down the piping or tubing with dry oil-free air or nitrogen to remove liquid by entrainment. Then circulate the purge gas until the final traces of the solvent have been removed. Purging can be considered complete when the solvent cannot be detected by appropriate methods in the gas venting from the vessel being purged.

A halogen leak detector may be used with chlorinated solvents for determining when a vessel is adequately purged. If the odor of solvent gases is detected in the vicinity of the effluent purge gas, the equipment requires additional purging. The method of test should be agreed upon by the manufacturer and the purchaser.

For equipment being used in oxygen service, it may be desirable to estimate the total quantity of oil or grease removed to justify future extensions of operating periods between washing or omissions of washing operations.

9. VAPOR DEGREASING

Vapor degreasing can be described as the removal of soluble organic materials from the surfaces of equipment by the continuous condensation of solvent vapors and their subsequent washing action.

9.1 Equipment. Commercial degreasers are available for cleaning metals at room temperatures. Vapor degreasing equipment consists essentially of a vaporizer for generating clean vapors from a contaminated solvent and a vessel for holding the parts to be cleaned in the vapor space.

9.2 Materials for Vapor Degreasing. The solvents frequently used for vapor degreasing are methylene chloride; refrigerant 11; perchloroethylene; 1,1,1-trichlorethane (Methylchloroform); and trichloroethylene. Some of these solvents are flammable in air under certain conditions and have varying degrees of toxicity. Caution should be exercised in their use. Dry oil-free air or nitrogen should be available for purging.

9.3 Vapor Degreasing Procedure. The following procedure is useful for cleaning cold or cryogenic equipment.

The temperature of a vessel must be between the freezing and boiling points of the solvent so that the solvent vapors will condense and

wash down by gravity over the equipment surfaces.

This cleaning procedure requires that the solvent be boiled in a vaporizer and the solvent vapors piped into a relatively cold vessel where the vapors condense on the cold surfaces. The equipment should be positioned and connected so that the condensate can be thoroughly drained from the system. Continuous removal of the condensate and its transport back into the vaporizer will carry the dissolved impurities into the vaporizer where they remain, as fresh pure vapors are released to continue the degreasing operation.

Cleaning can be considered complete when the returning condensate is as clean as the unused solvent.

NOTE: The vapor degreasing action will stop when the temperature of the vessel reaches the boiling point of the solvent.

9.4 Removing Solvent Vapors. The solvent should be removed by following the procedure in Section 8.6.

10. MECHANICAL CLEANING

This type of cleaning may be accomplished · blast cleaning, wire brushing, or grinding.

10.1 Blast Cleaning. Blast cleaning may be described as the use of abrasives propelled through nozzles against the surface of pipe, fittings, or containers to remove mill scale, rust, varnish, paint or other foreign matter. The medium propelling the abrasive shall be oil-free unless the oil is to be removed by subsequent cleaning. Specific abrasive materials shall be suitable for performing the cleaning without depositing contaminants that cannot be removed by subsequent cleaning. Care is to be taken when blast cleaning so as not to remove an excessive amount of parent metal. The blasting medium and residue shall be removed to meet the cleanliness levels suggested herein for oxygen service equipment.

10.2 Wire Brushing or Grinding. Accessible surfaces may be wire brushed. Welds may be ground and wire brushed to remove slag, grit, or excess weld material. Carbon steel wire brushes shall not be used on aluminum or stainless steel surfaces. Any wire brushes previously used on carbon steel shall not be used on aluminum or stainless steel surfaces.

Tumbling. Tumbling can be described as a cleaning method that uses a quantity of hard abrasive material placed in a container to clean the internal surfaces. The container and the abrasive are energized so as to impart relative motion between the abrasive material and the container.

10.4 Swabbing, Vacuuming. Equipment, parts or piping may be vacuum cleaned after mechanical cleaning to remove loose particles of dirt and slag.

If vacuum cleaning is not possible the surfaces may be swabbed with a suitable solvent using a clean lint-free cloth to remove loose dirt, slag, etc.

10.5 Blowing and Purging. After the equipment, parts and piping have been mechanically cleaned and any abrasive material removed, the assembled piping should be blown with dry, oil-free air or nitrogen to remove small particles and any solvent vapors present.

If drying is not completed with the residual heat in the metal, it can be completed with dry oil-free air or nitrogen. If it is desirable that the equipment be maintained in a dry atmosphere before installation or use, the dew point of the contained atmosphere should not be above —30 F (—34 C).

11. INSPECTION.

11.1 Approval of Quality Control—Procedures and Standards. Detailed quality control standards and procedures should be agreed upon between the manufacturer and the purchaser. A source inspection by the purchaser's representative at the manufacturer's location may be desirable.

The purchaser should initially and periodically inspect the manufacturer's facilities and audit cleaning and quality control procedures.

11.1.1 Record Keeping. Records of the following information as applicable should be prepared for the cleaned equipment or assembly, kept on file, and if requested, a copy forwarded to the purchaser.

(a) A descriptive name of the item covered.
(b) Its serial number.
(c) Its invoice number or other means of identification.
(d) The cleaning specification and method employed.
(e) The dates of inspection for cleanliness.
(f) The method of inspection.
(g) The results of inspection.

(h) The inspector's signature and date signed.

11.2 Inspection Procedures. When specified by the purchaser, any one or combination of the following tests shall be used to assess the cleanliness of a piece of equipment. Failure to pass any of the specified tests requires recleaning and reinspection and may require re-evaluation of the cleaning procedures. In-process inspections to assure adequacy of cleaning procedures may be desirable.

11.2.1 Direct Visual Inspection (White Light). This is the most common test used to detect the presence of contaminants such as oils, greases, preservatives, moisture, corrosion products, weld slag, scale, filings and chips and other foreign matter. The item is observed for the absence of contaminants (without magnification 20/20 vision) under strong white light and for the absence of accumulations of lint fibres. This method will detect particulate matter in excess of 50 microns (.002") and moisture oils, greases, etc. in relatively large amounts.

11.2.2 Direct Visual Inspection (Ultraviolet Light). Ultraviolet light causes many common hydrocarbon or organic oils or greases to fluoresce when they may not be detectable by other visual means. The surface is observed in darkness or subdued light using an ultraviolet light radiating at wave lengths between 2,500 and 3,700 Angstrom units. Ultraviolet (black light) inspection shall indicate that cleaned surfaces are free of any hydrocarbon fluorescence. Accumulations of lint or dust that may be visible under the black light shall be removed by blowing with dry oil-free air or nitrogen, wiping with a clean lint-free cloth or vacuuming. Not all organic oils fluoresce and some materials such as cotton lint that fluoresce are acceptable unless present in excessive amounts. If fluorescense shows up as a blotch, smear, smudge, or film, reclean the fluorescing area.

11.2.3 Wipe Test. This test is used to detect contaminants on visually inaccessible areas as an aid in the above visual inspections. The surface is rubbed lightly with a clean white paper or lint-free cloth which is examined under white and ultraviolet light. The area should not be rubbed hard enough to remove any oxide film as this could be confused with normal surface contamination.

11.2.4 Water Break Test. This test may be used to detect oily residues not found by other means. The surface is wetted with a spray of clean water. This should form a thin layer and remain unbroken for at least five seconds. Beading of the water droplets indicates the presence of oil contaminants. This method is generally limited to horizontal surfaces.

11.2.5 Solvent Extraction Test. This method may be used to supplement visual techniques or to check inaccessible surfaces by using a solvent to extract contaminants for inspection. The surface is flushed, rinsed or immersed in a low residue solvent. Solvent extraction is limited by the ability of the procedure to reach and dissolve the contaminants present. Components of the equipment tested may also contain material which would be attacked by the solvent and give erroneous results.

The used solvent may be checked to determine the amount of non-volatile residue. A known quantity of a representative sample of filtered used solvent is evaporated almost to dryness, then transferrd to a small weighed beaker for final evaporation, being careful not to overheat the residue. In the same manner, the weight of residue from a similar quantity of clean solvent is determined. The difference in weight of the two residues and the quantity of solvent used should be used to compute the amount of contaminant extracted per square foot of surface area cleaned.

In a similar manner, a one liter representative sample of the unfiltered used solvent can be placed in an Imhoff cone and evaporated to dryness. The volume of residue can be measured directly and used to compute the amount of contaminant extracted per square foot of surface area cleaned. Greater sensitivity can be achieved by evaporating successive liters of solvent in the same Imhoff cone.

Another method is to take a sample of known quantity of the used solvent and compare it to a similar sample of new solvent by comparing light transmission through the two samples simultaneously. There should be little, if any, difference in color of the solvents and very few particles.

Hydrocarbon or particulate matter residues determined by the inspection procedure shall not exceed the amount specified by the purchaser. An acceptable contamination level for oxygen service equipment is about 100 mg per square foot but could be more or less depending on the specific application (state of fluid, temperature and pressure).

11.2.6 Particle Count. If the purchaser's requirement includes a particle and fiber count, a representative square foot of surface shall

show no particle larger than 1000 microns and no more than 50 particles between 500 and 1000 microns. Isolated fibers of lint shall be no longer than 2000 microns and there shall be no accumulation of lint fibers.

12. PACKAGING AND LABELING

12.1 Protection from Recontamination. Once a piece of equipment has been cleaned for oxygen service and the cleaning agent completely removed from the equipment, it should be suitably protected as soon as practicable to prevent recontamination during storage and prior to being placed in service.

Following are several ways in which this can be done. The protection provided will depend on a number of factors such as the type of equipment, length of storage and atmospheric conditions. The type of protection required should be specified by the purchaser.

12.1.1 Protection of Openings. Equipment or parts having small openings may be protected by caps, plugs, cartons, sealing equipment in plastic bags, or by other appropriate means.

Openings on large equipment may be sealed, preferably with caps, plugs or blind flanges where appropriate. Taped solid board blanks or other durable covers which cannot introduce contamination into the equipment when removed can also be used to seal such openings.

12.1.2 Pressurization. Equipment with large internal volumes may be filled with dry oil-free air or nitrogen after all openings are sealed and valves closed.

Parts in suitable plastic bags may be inerted or evacuated.

12.2 Labeling. Where purchaser's requirements include labeling to show oxygen cleaning of parts or equipment, a statement, "Cleaned for oxygen service" or other suitable wording should appear on the part, or package as applicable. Additional information which may be included is as follows:

(a) A statement, "This equipment is cleaned in accordance with Oxygen Cleaning Specification No. _______".

(b) Date of inspection and inspector's stamp or marking.

(c) Description of part, including part number if available.

(d) Statement, "Do not open until ready for use".

PERSONNEL SAFETY

Cleaning operations for oxygen service equipment shall be carried out in a manner which provides for the safety of personnel performing the work and shall conform to the local ordnances and state and federal regulations.

13.1 Instructions and Supervision. Operators shall be instructed in the safe use of the cleaning agents employed, including any hazards associated with the use of these agents. Written instructions shall be issued whenever special safety considerations are involved. A responsible individual shall direct oxygen cleaning operations.

13.2 Dangerous Chemicals. No highly toxic chemicals shall be used. Carbon tetrachloride shall not be employed in any cleaning operation.

The health hazards associated with the use of any solvent shall be considered in its selection. The user shall ensure that the TLV time weighted average is not exceeded for a specific solvent and consider that some chlorinated solvents are suspected of being carcinogenic. Breathing of solvent fumes and liquid contact with the skin should be avoided.

Caution must be exercised in using solvents commonly referred to as non-flammable that are flammable in air under certain conditions. The concentrations creating a flammable mixture in air are usually well in excess of the concentrations that cause physiological harm. Therefore on removing solvents to the extent necessary to protect personnel from respiratory harm, it must not be forgotten that purging with air can create a flammable mixture and that failure to purge adequately can leave a flammable mixture which in the presence of heat, flame or sparks may result in a dangerous energy release.

Follow normal industry procedures in the mixing and handling of acids and caustics to eliminate injuries.

13.3 Protective Equipment. Face shields or goggles shall be provided for face or eye protection from cleaning solutions.

Safety glasses with side protection shall be provided for protection from injuries due to flying particles in the air.

Protective clothing shall be provided when required to prevent cleaning solutions from contacting the skin.

A self-contained breathing apparatus (see ANSI Z88.2 Practices for Respiratory Protection) shall be provided wherever there is a

possibility of a deficiency of oxygen due to the use of an inert gas purge or if there is any possibility of exceeding allowable TLV values.

13.4 Proper Ventilation. All areas where cleaning compounds and solvents are used should be adequately ventilated. In outdoor operations, locate cleaning operations so that operators can work upwind of solvent vapor accumulations.

13.5 Special Situations

13.5.1 Entering Vessels

13.5.1.1 Work should not be performed inside a vessel or confined area until the vessel or confined area has been properly prepared and work procedures established that will ensure the safety of the worker.

13.5.1.2 A Hazardous Work Permit (HWP) is an instrument widely used in industry for ensuring safe working conditions and its use is strongly recommended. The HWP should consider at least the following items before anyone enters a vessel or confined space. Other considerations may be required depending on the type of work being performed. For example, a vessel should not be entered until its temperature is at or near the surrounding temperature. All workers involved with any vessel entry should be fully apprised of the total operation prior to any tank entry.

(a) *Isolation:* All lines to a vessel should be suitably isolated to prevent the entry of foreign materials, in particular the atmospheric gases (nitrogen, argon or the rare gases) that cause asphyxiation by oxygen depletion. Oxygen enrichment is also to be avoided because of the associated fire hazard. Acceptable means of isolating vessels are blanking, double block and bleed valves or disconnecting all lines from the vessel.

(b) *Periodic Monitoring:* The need for periodic monitoring of the atmosphere in any vessel or confined space shall be considered before any work is performed.

(c) *Ventilation:* A fresh air supply suitable for breathing is normally supplied to the vessel when personnel are inside.

(d) *Atmospheric Analysis:* The atmosphere in a vessel that has been in service or has been inerted must always be analyzed before entering to determine that the vessel or confined area has been adequately ventilated with fresh air and is safe for personnel.

(e) *Rescue Procedure:* A reliable procedure for removing personnel from any vessel or confined work space should be available and understood by all workers before any work begins.

(f) *Work Procedure:* When cleaning operations are performed inside oxygen vessels or other such confined spaces a reliable preplanned procedure for quickly removing or protecting personnel in cases of emergency shall be established and understood by all workers before work begins.

(g) *Watcher:* When toxic cleaning agents are used it is recommended that, a watcher be stationed immediately outside a vessel or confined space to ensure the safety of those working within. A portable air breathing supply shall be immediately available.

13.5.1.3 Personnel must not enter any vessel unless its atmosphere has a normal air composition. Normal atmospheric air has twenty one percent oxygen by volume. However, it is permissible to work in atmospheres having oxygen concentrations in the range of nineteen to twenty-three percent if the other gases present do not exceed their threshold limit valves. In the event that the oxygen concentration deviates from twenty-one percent, a review of the system is required to assure that oxygen or an asphyxiant is not entering the vessel.

13.5.2 Heating Solvents. Chlorinated solvents upon heating can break down to dangerous compounds. A commonly used solvent, trichlorethylene, decomposes at temperatures not far above the boiling point of water. Ventilation must be adequate to prevent breathing excessive amounts of the solvent vapors or their decomposition products. Air respirators must be used in situations where the concentration of solvent vapors or any other foreign material in the atmosphere exceeds their TLV limit.

13.5.3 Welding Near Solvents. It is important to ensure that parts to be welded shall be free of cleaning solvents. Ultraviolet rays from welding can decompose certain chlorinated solvents to produce phosgene gas. Accordingly the atmosphere in the vicinity of such operations shall be free from chlorinated solvent vapors.